

# **Comparative Depositional Environment of Kadapperikuppam and Niniyur Formations of Paleocene Age**

Singarasubramanian.S.R.<sup>1</sup>, Alankruta Biswal<sup>2</sup> and Kamalesh Mahalingam Iyer<sup>2</sup>

Associate Professor, Department of Earth Sciences, Annamalai University, Annamalainagar, Tamil Nadu, India <sup>1</sup>

PG Student, Department of Earth Sciences, Annamalai University, Annamalainagar, Tamil Nadu, India <sup>2</sup>

**ABSTRACT:** Marine cretaceous rocks of east cost India have occupied a position in correlating the events in the Indo Pacific region with those of Tethyan. Albian/Cenomanian major transgression has resulted in the sedimentation of clastic and carbonate rocks along the basin margin. These outcrops exposed in Pondicherry, Vridhachalam and Trichinopoly. Among the outcrops upper Cretaceous rocks, the Pondicherry outcrop is located on the northern limit of Cauvery basin. These Marine rocks with a rich and varied fauna were investigated since their recognition. The study area, Pondicherry, has received wide geological attention, since the recognition of an interesting suite of fossiliferous marine rocks. The present study aims to elucidate the paleoenvironmental conditions of deposition of the Kadapperikuppam Limestone based on sedimentological and faunal attributes and have a comparison with Niniyur formation of Ariyalur Stage.

**KEYWORDS:** Tethyan, Cenomanian, Paleoenvironmental. Niniyur formation

## **I. INTRODUCTION**

Albian/Cenomanian major transgression has resulted in the sedimentation of clastic and carbonate rocks along the basin margin. These outcrops exposed in Pondicherry, Vridhachalam, Trichinopoly. Among the outcrops upper cretaceous rocks, the Pondicherry outcrop is located on the northern limit of Cauvery basin. These Marine rocks with a rich and varied fauna were investigated since their recognition. A large number of workers devoted their attention mostly to the fauna present in them, in a attempt to assign their age and have added to our knowledge on the stratigraphy, paleontology, and paleoecology with less concentration on sedimentology of cretaceous Eocene rocks of Pondicherry area.

The study area, Pondicherry, has received wide geological attention, since the recognition of an interesting suite of fossiliferous marine rocks. Rama Rao (1960) have studied the Cretaceous Tertiary Boundary problem of this area. Murthy (1965) have done a systematic geological mapping of Pondicherry area and portion of Cuddalore district. Blanford (1862) first published the earliest geological account of the Cretaceous rocks of Pondicherry area. ONGC has carried out detailed geological, geophysical and laboratory studies to determine the stratigraphic and lithologic characteristics of various formations met within Pondicherry region. Oil and Natural Gas Commission concluded that the carbonates in the outcrop area show a facies variation to deep water clastics in the down dip areas.

## **II. STUDY AREA**

Pondicherry region is a flat, monotonous plain with an average elevation of about 15m above mean sea level. The terrain becomes a little undulating with prominent high grounds varying from 30 to 45m above mean sea level towards interior north-eastern part of the region (Map No.1).

The three major physiographic units generally observed in the study area are (i) coastal plain (ii) alluvial plain and (iii) uplands. The coastal plain extends as a narrow stretch of 4 to 600 meters width on the eastern part of the region

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along the Bay of Bengal. The Eastern Highland forms an elevated bench with respect to other geological formations and shows some development of erosion at its lateral fringes.

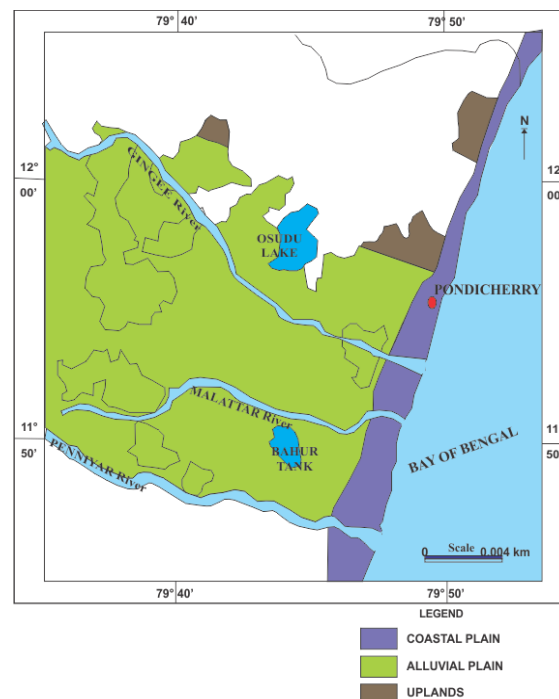
Second physiographic unit, the alluvial plain has been formed by two major rivers namely, Gingee and Ponnaiyar rivers that pass through the area occupying major portion of Pondicherry region. The Gingee river runs to its South of the Cretaceous outcrop area and due to its influence, the area is covered by recent alluvium. This is generally a monotonous plain with slope ranging from 1 to 3%.

The third physiographic unit, the northwestern uplands include undulating high grounds with elevation of about 30 to 40 meters above mean sea level and are intersected by a number of gullies and deep ravines giving rise to bad land topography.

The upper Cretaceous rocks of Pondicherry area mark the northern limit of the sediments laid during the great Cenomanian marine transgression along the East Coast of South India. The rock types include hard and massive limestone, marl, sandy and calcareous shale, shell limestone and calcareous sandstone.

In the major part, the sedimentary formations (laterite and sandstone) of Pleistocene and Mio-Pliocene periods are exposed. Sedimentary Formations (Clay and limestone) of Paleocene period are exposed in the westernmost part.

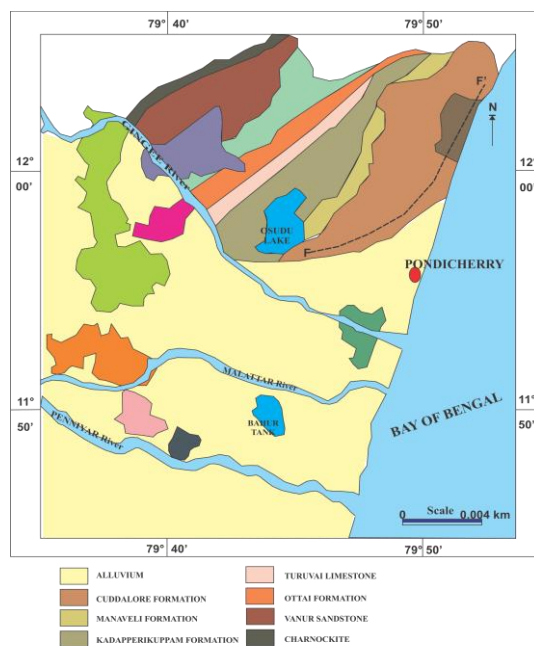
The geological map (modified from Ramanathan and Babu, 1967) showing the outcrops of the area is presented in map No.2. The various litho units encountered in Pondicherry area commencing from Archaean basement has been described in chronological order. The Archaean crystalline rocks comprise charnockites and biotite-hornblende gneisses form the basement to the thick pile of Mesozoic and Tertiary sediments. The Cretaceous outcrops met within the Northwest portion of the region and Northeast of Gingee (Varahanadhi) is divisible into four formations viz., Ramanadhopuram Formation (not exposed on the surface), Vanur Sandstone, Ottai Claystone and Thuruvai Limletstone. The Paleocene rocks in the region are represented by Kadapperikuppam Formation and Manaveli Formation. The Upper Tertiary rocks are represented by Cuddalore Formation. Recent Alluvium in the area is composed of gravel, sand, silt, clay and kankar. The thickness of alluvium is maximum along the river.



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Map No.2 Showing Geology of the Study region

## III. MATERIAL AND METHODS

The location map of the study area forms part of the survey of India toposheets 58M/9 and 58M/13. Kadapperikuppam Limestone was collected from an open mining area at Thondamanatham, west of Pondicherry town (Plate –I). Fresh samples were collected in polythene bags from the field using hammer and numbered. The samples are mainly carbonate rocks (limestone) with some marl content.

The rock samples were broken into small size to make thin section. The thin sections were studied under petrological microscope to know its mineralogical constituent, faunal content and cementation. Thin sections were partially subjected to staining test (Reid, 1969) to understand the type of carbonates. For staining Alizarin red, Hydrochloric acid (HCl) and potassium ferricyanide were used to prepare the solution as per standard procedure.

## IV. PETROGRAPHIC STUDIES

### KADAPPERIKUPPAM FORMATION

Turuvai limestone is overlain by the Kadapperikuppam Formation, which has a composite lithology, and rapid lithofacies variation could be observed laterally and vertically. The surface samples collected were used to decipher the petrography of the formation. Rock types include calcareous sandstone (Plate- I, B), sandy claystone (Plate- I, C), algal limestone (Plate- I, C) and marlstone (Plate- I, A). Rajagopalan (1965) has named these Paleocene sediments as Pondicherry Formation and has subdivided it into four litho units namely lower marlstone, algal limestone, discocyclinid limestone (Danian age) and an upper marlstone (equivalent to Manaveli Formation).

As per the present field observation frequent lithofacies variation due to frequent intercalations were noticed. The lithounits are intensively bioturbated in some places. Litho units identified are calcareous sandstone, sandy claystone, algal limestone and marlstone. Lower part is more argillaceous.

### Foraminiferal algal sandy packstone:

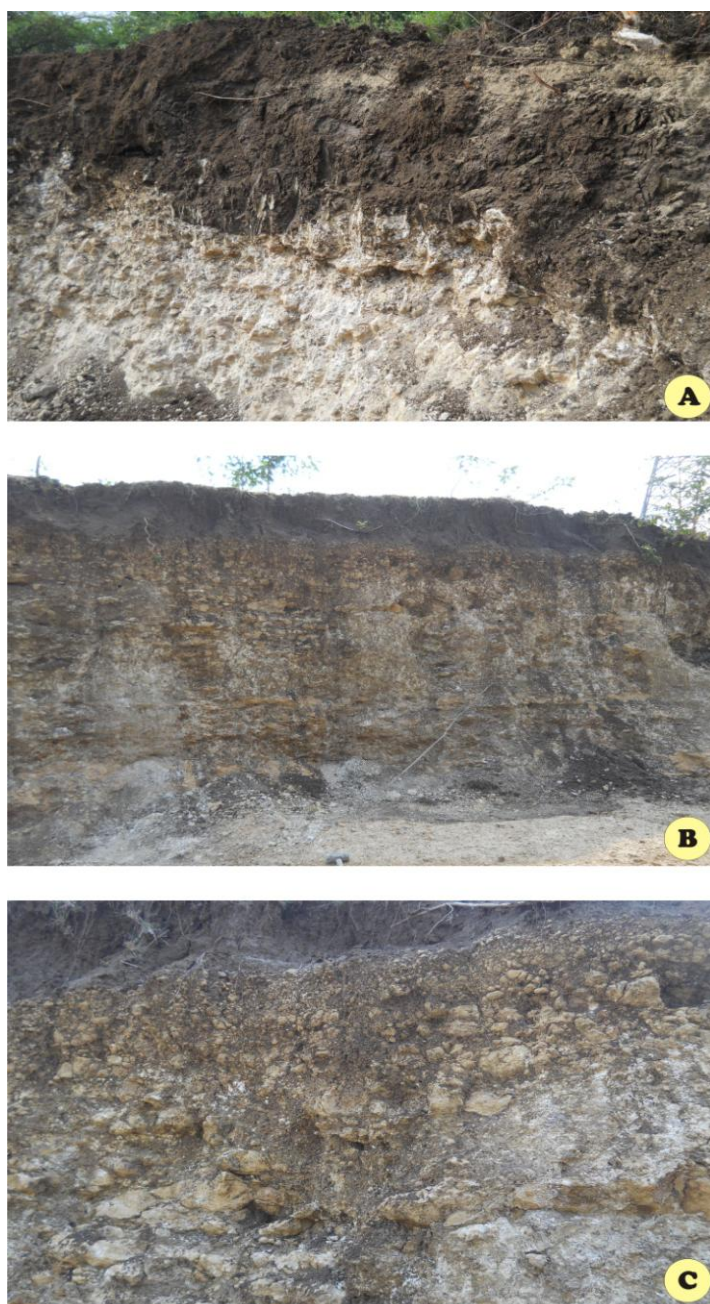
Samples from Thondamanatham exhibits rounded grain framework, slender algal bioclasts and crinoids float in silt sized carbonate matrix. Medium to coarse mostly colourless, anhedral, without cleavage, refractive indices less than canadabalsm, having low relief with first order grey interference colour and twinning absent grains of quartz. Minor

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amount of colourless, subhedral having perfect and imperfect cleavage, low relief, first order grey interference coloured grains of K-feldspar together with yellowish green and pleochroic pellets of glauconite, firmly cemented with calcite (Plate- II). Pellets are microcrystalline in nature. Abundant coralline red algal slender filaments are bound together as ribbon like bands with sparry calcite occupying the interspace between the filaments (Plate- II). Many bioclasts have been leached and the voids are filled with sparry calcite. The association of glauconite with organic matter indicates local reducing conditions.



**Plate-I FIELD PHOTOGRAPHS A- UPPER CLAY AND MARLSTONE; B-SECTION OF SANDY LIMESTONE; C- VIEW OF ALGAL LIMESTONE**



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Section composed of coralline algae, molluscan fragments, smaller foraminifera, melobasian, discocyclinid and bryozoan fragments. Some organic fragments are also noticed along with medium to coarse sand set in a sparry calcite matrix. Larger foraminiferal tests (Plate II), discocyclinid and bryozoan colonies together with coarse sand are set in a sparry calcite mosaic and fairly abundant red algal filaments (Plate II). The texture and composition of these Kadapperikuppam formation leads to classify them as “Packstone” (Dunham,1962) and “Biosparite” (Folk,1959).

## NINIYUR FORMATION

Rocks of Niniyur group comprise fossiliferous limestone and cherts. The beds are made up of brown and grey sandstones, shales and arenaceous limestones. The presence of fossil algae was first recognized by L.R.Rao (1931). Previous works on the Calcareous algae of the Niniyur formation was carried out by Rao and Pia, 1936; Rao and Gowda, 1953, 1954; Kishore, 2001). The Niniyur formation was assigned the Danian (early Paleocene) age. Subsequent work revealed the presence of planktonic foraminifera in the Niniyur formation. The most distinguishing feature of this formation is the rich representation of the fossil algae (Rao, 1958). Three distinct units recognized in the Niniyur formation are: Lower fossiliferous limestone (Adanakkurichi); Middle subcrystalline limestone (Mattur, Niniyur); and the Upper argillaceous gritty nodular limestone (Sendurai). The sequence comprises subcrystalline to crystalline shell limestone. The general Lithology shows compactive hard limestone at the base and the marl beds above. The calcareous algae are present in bands. The coralline red algae are abundantly represented in the Niniyur Formation as fragments. Acicularia as spicules (Plate- III A & B) occur more commonly in the section.

Environmental characteristics shown by Sporolithaceans (Plate – III C & D) restricted to low-latitude areas occur in deep water and cryptic reef habitats. Broadly distributed Melobesoids (Plate – III E) occupy deep water habitats in low latitudes. These two groups suggest deposition in reefal environment below 20m (Kishore and Singh, 2004). Corallina (Plate – III, F) genera generally live in the water less than 30m deep and are common at depth between 200 and 25m (Johnson, 1957).

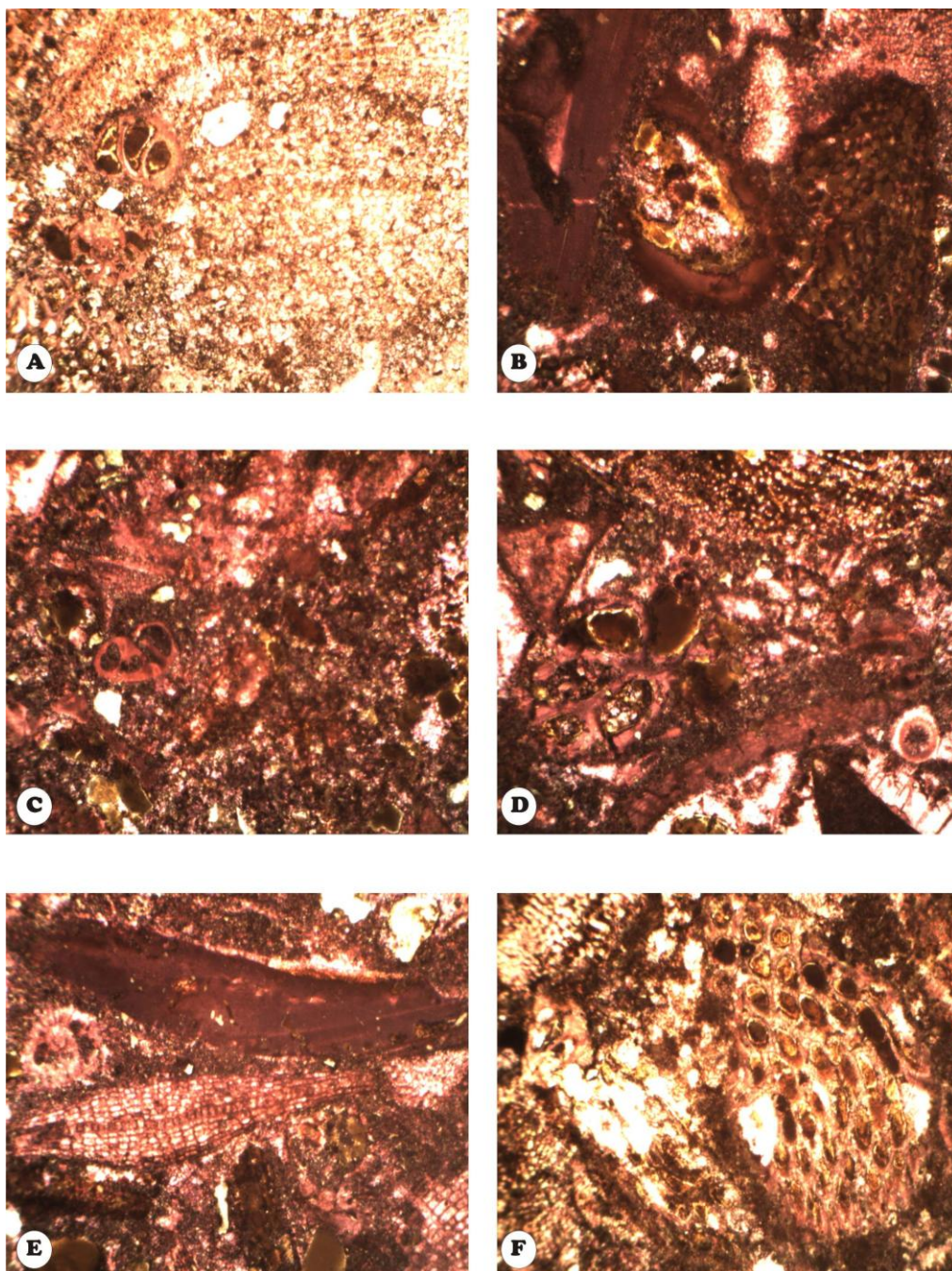
## V. SUMMARY AND CONCLUSION

The most remarkable feature of Niniyur formation is their unique lithology and biota especially the occurrence of numerous algae. Three distinct lithotypes are identifiable within the Niniyur formation viz., Lower fossiliferous limestone; middle recrystalline shell limestone and the upper argillaceous gritty nodular limestone. The five litho units P<sub>1</sub> – P<sub>5</sub> of Pondicherry area are studied by Rama Rao. Thus, the Late Cretaceous succession of Pondicherry ranges from early Santonian to early Maestrichtian and thus is equivalent to the middle and upper parts of the Lower Ariyalur stage of Vridhachalam area.

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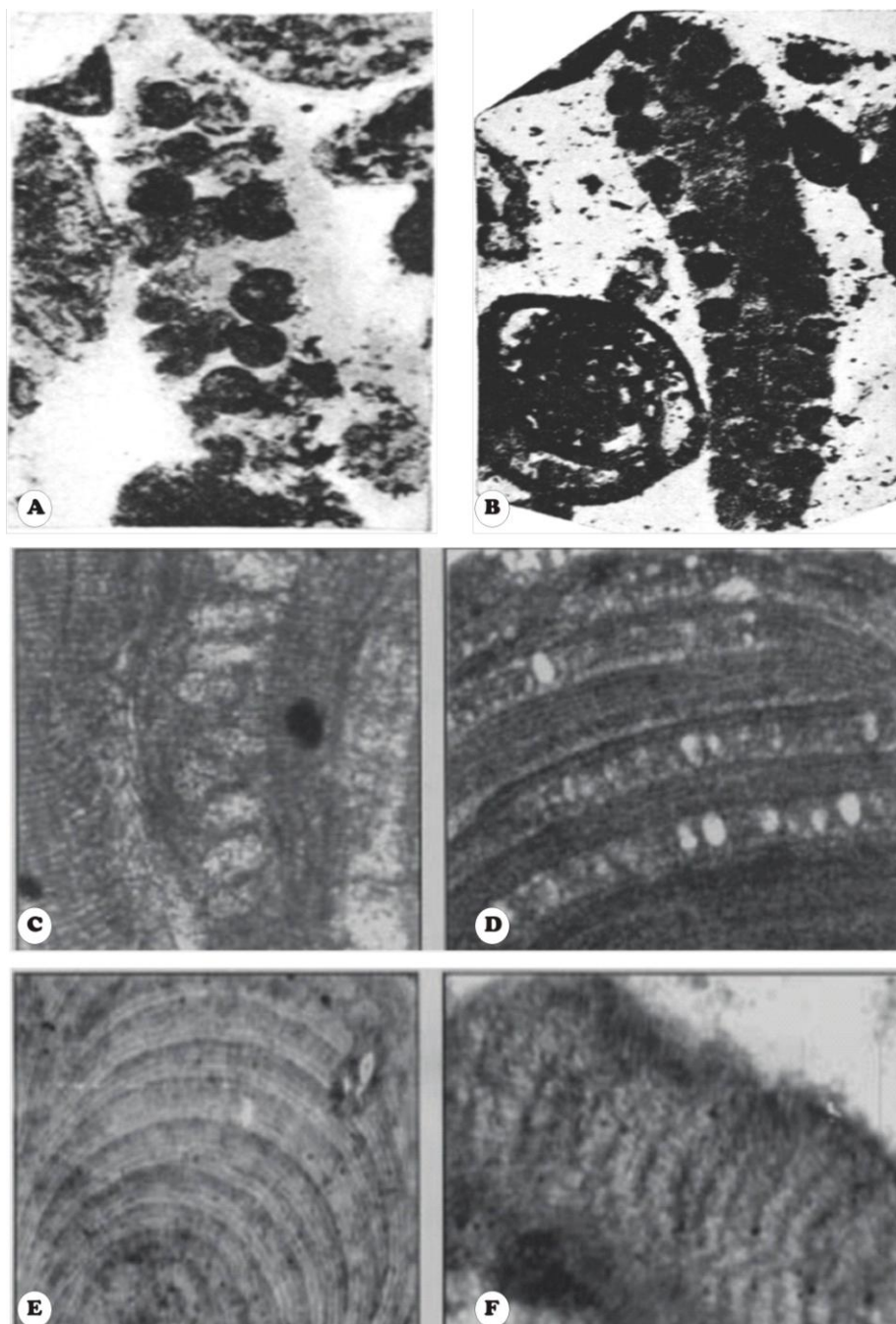
**Plate-II MICROPHOTOGRAPHS (10X) A- FORAMINIFERA IN SPARRY CALCITE MATRIX; B-RED ALGAE AND BRYOZOANS; C-FORAMINIFERAL PACKSTONE; D-MELOBASIAN AND CRINOID OSICILE; E- LEPIDODENTRON AND MELOBASIAN; F- BIOCLASTIC PACKSTONE SHOWING DISCOCYLINID**



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**Plate-III THE ALGAE OF NINNIYUR FORMATIONS A & B ACICULARIA INDICA Sp. (Varma, 1954); C & D - SPOROLITHION Sp.; E- MELOBESIOIDEAE Sp.; F- CORALLINA Sp. (Kishore and Singh, 2004)**

Rock types of Kadapperikuppam formation include calcareous sandstone, sandy claystone, algal limestone and marlstone. Rajagopalan (1965) has named these Paleocene sediments as Pondicherry Formation and has subdivided it into four litho units namely lower marlstone, algal limestone, discocyclinid limestone (Danian age) and an upper marlstone (equivalent to Manaveli Formation). Many bioclasts have been leached and the voids are filled with sparry

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calcite. The association of glauconite with organic matter indicates local reducing conditions (Singarasbramanian, et.al 2005).

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## Environment of deposition:

After the deposition of Turuvai limestone in a high energy zone, there was a relative sea level rise which has been recorded as Thanetian transgression in many parts of Cauvery Basin. Presence of abundant red algal boundstone and larger foraminiferal test point towards fluctuating shallow innershelf conditions within a photic zone. It was evidenced by Guha and Mukhopadhyay (1996) that the texture and presence of algae, molluscs and echinoderm plates of the Kadapperikuppam Formation point to its deposition on an open platform or shallow marine shelf with variation in energy condition within the basin.

Thus, the depositional condition of Kadapperikuppam Formation is confirmed with the equivalent of Paleocene Formation in the Ariyalur area, which is formed under shallow marine inner shelf environment. The formation was assigned Danian age equivalent of Ninniur formation of Trichinopoly.

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