

# Nummulites (Foraminifera) from Pondicherry area and Paleobiogeographic Implications

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**Abstract:** The study reports an interesting *Nummulites* fauna from the late Palaeocene- early Eocene sediment of Pondicherry area. The taxa *Nummulites* are recovered for the first time from the sediments exposed at Saidarpet and Thondaimanattam quarry sections of Pondicherry area. The biostratigraphy and paleobiogeographical implications of this *Nummulites* fauna are significant. The taxa was previously known only from Pakistan and now it has a broad geographical distribution, covering Europe from the Pyrenees to the North Atlantic, west and North Africa, West Africa, Oman, Pakistan, Libya and western Ireland. The fauna therefore show marked mixing of taxa from Indian subcontinent, the Mediterranean/North Atlantic and West African region as well as including a taxon previously considered endemic to the Caribbean. The occurrence of *Nummulites* in association with *Discocyclinids* and trace fossils at Thondaimanattam quarry section and also in calcareous limestone in Saidarpet clearly indicate that the warm shallow water and more open marine environment. The *Nummulites* illustrated herein come mainly from Karasur Formation and is thus dominantly Thanetian (NP8-NP9) in age close to the Palaeocene-Eocene boundary (Nannoplankton Zone NP8 –NP10) possibly ranging as high as top NP11.

**Key words:** Nummulites, Foraminifera, Paleocene, Pondicherry, Cauvery Basin.

## 1. Introduction

The Pondicherry area includes the northernmost of the three outcrops of marine sediments which occur as detached patches along the coast of Tamilnadu, South India (Fig.1). The lithostratigraphy of the Pondicherry area of South India contains a succession of upper Cretaceous to early Eocene sediments consisting mainly of marls, algal limestone, marly limestones and fine-grained sandstones. These rocks have been of interest to geologists and paleontologists since the middle 1800s when Blandford [2] published the first report. The presence of marine lower Tertiary sediments was first reported by Furon and Lemoine [5] who noted the occurrence of the larger foraminifera *Assilina* and *Discocyclina*. Subsequently, Rao [8] and Rao et al., [9] reported the outcrops of *Discocyclina-Nummulites* bearing limestone which they regarded as Paleocene in age. Since then several workers have reported on the early Tertiary sediments of the region. Sastry et al., [13] studied the coralline algae from the *Nerinea* beds. The planktonic foraminiferal stratigraphy was reported by Gowda [6] and discussed the significance of the Eocene bituminous limestones for hydrocarbon potential. Rajagopalan [10 &11] inferred the existence of Paleocene sediments in the area and also discussed the Cretaceous-Tertiary boundary problem in India and adjacent countries. He also mapped the sediments, determined the lithostratigraphy and classified the Cretaceous-Paleogene rocks into late Cretaceous Valudavur and Mettveli Formations and the Palaeocene Pondicherry Formation. The Pondicherry Formation is of early Tertiary age and the other two are of Upper Cretaceous. It is essentially of carbonate sequence of fossiliferous marl, limestone and calcareous fine grained sandstone. Rajagopalan [11] divided the formation into four informal lithological units, the lower marlstone, the algal limestone, the *discocyclinids* limestone and the upper marlstone. On the basis of the planktonic foraminifera first he assigned Paleocene to early Eocene age to the Pondicherry Formation, but later on reexamination of the fauna, he opined that it is of

Paleocene age only. His observations were not supported by a systematic account of the planktonic foraminiferal fauna. Later Samanta [14] examined the material and assigned Paleocene age and the assemblage in the *discocyclinid* limestone units as transitional in age between Paleocene and lower Eocene, provisionally he assigned to the upper most part Paleocene. Sundaram [12] subdivided the Pondicherry Formation into the Karasur and Manaveli Formations.

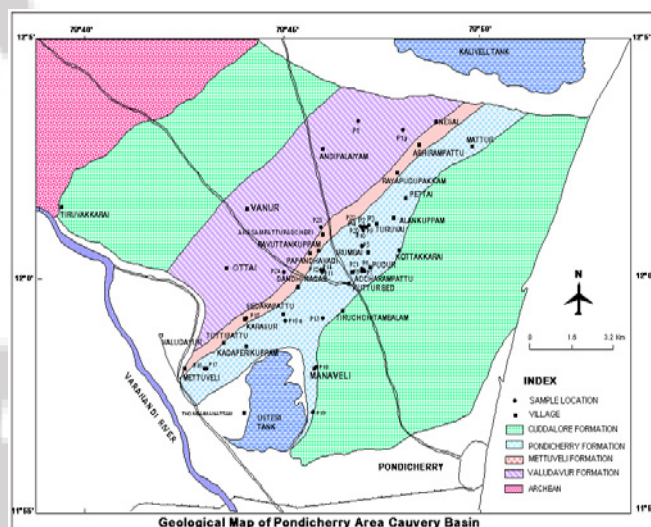


Figure 1: Geological Map of Pondicherry area, Cauvery Basin

## 2. Geological Setting and Methods

The Cauvery basin represents a passive margin sedimentary system that developed in response to the separation of the Indian subcontinent from Australia and Antarctica in the early Cretaceous-late Jurassic, contemporaneous with the first phase of seafloor spreading responsible for the formation of the Indian Ocean. The basin forms a half graben morphology trending NE-SW with a regional dip 5°-10° to the east and southeast due to continental rifting

between India, Australia and Antarctica plates (Veevers et al., 1991). In the Cauvery basin, Cretaceous-Tertiary strata consisting sediments mainly of marls, algal limestone, marly limestones and calcareous fine grained sandstone, claystones, are exposed in Tiruchirapalli, Vrindhachalam and Pondicherry along the east coast of south India (Fig. 4). Around Pondicherry these rocks occupy an area of nearly 30 sq. miles NW of Pondicherry. The study area is situated to the NE of the city of Pondicherry where Palaeocene to early Eocene rocks are well exposed. The samples for the present study algal *discocylinid* limestone were collected from the dug well and excavated house foundation and also well – cutting in the village of Saidarpet near the coconut farm behind the rice mill (N 11o59'36.7":E79o45'0.5"); calcareous marlstone and claystone were collected from the NE of the village Tiruchitrabalam – Saidarpet Cross road Bridge cutting (N 12o00'5.3": E79o46'33.6") and calcareous fined grained sandstone, behind the temple of the village Papanchavadi (N 12o00'49.0":E79o46'08.7") and in the pond section of the village Ravathamkuppam (N 12o00'55.7":E79o46'33.6") in the Pondicherry area.

### 3. Nummulites (Foraminifera)

The Palaeocene sequence of Pondicherry area consists dominantly of limestone, shale and marl. The upper part of the sequence consisting of middle Eocene includes variegated clay, sandstone, siltstone, mudstone and fossiliferous limestone layer. The palaeocene sedimentary units of the study area are characterized by the development of foraminiferal assemblages. The early tertiary sediments of Pondicherry contain both smaller and larger foraminifera. The larger benthic foraminiferal species belong to genera *Nummulites* and *Discocyclina*. Approximately 10 samples of assumed late Palaeocene age were collected, thin sectioned and where possibly disaggregated to extract *Nummulites* foraminifera. Sections yielded *Nummulites* from Discocyclinid limestone member exposed at Saidarpet and Thondaimanattam quarry sections sediments of Pondicherry area (Plate 1). *Nummulites* also occur in association with Discocyclinid and a variety of extraordinarily well preserved trace fossils from the Palaeocene sediments of Thondaimanattam quarry section. Although the larger foraminifera (*Nummulites*) reported herein are difficult to identify in species level without matrix free material and oriented thin sections, it is possible to use the simple classification scheme to identify general from random thin section (especially hard limestones). The Thondaimanattam quarry section consists of endichnial structures in the arenaceous limestones which are highly bioturbated and shows good preservation of horizontal structures. It is commonly dominated by the cylindrical, branched, large size three dimensional horizontal feeding burrows of *Thalassinoides* with *Planolites* and *Palaeophycus*. Degree of bioturbation is very high within the arenaceous limestone and appears to be as mottled burrows (*Thalassinoides*). The main objective of the study was to report the morphology of the *Nummulites* and probable environment of deposition. The biostratigraphy and paleobiogeographical implications of this *Nummulites* fauna are significant.

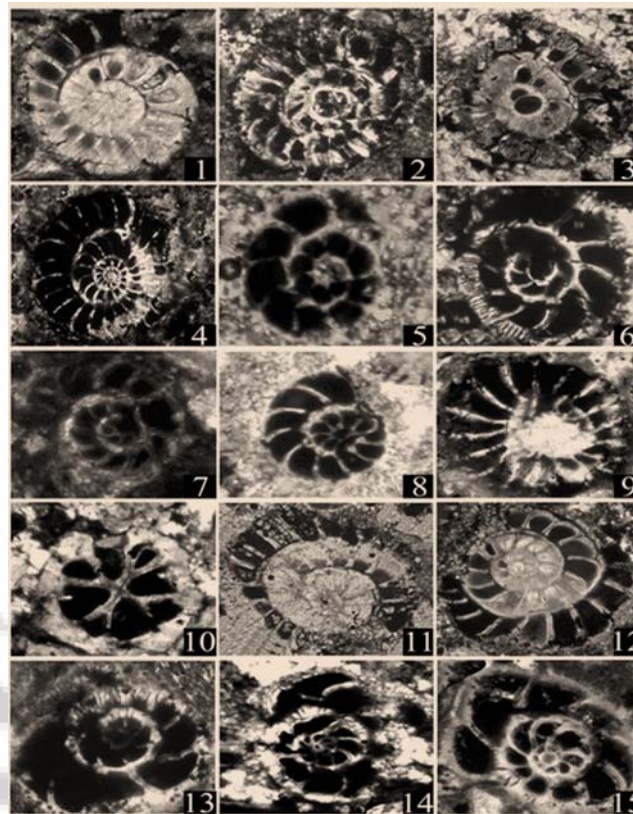


Plate 1: Figs. 1-15 *Nummulites* sp., (Saidarpet and Thondaimanattam Quarry sections).

### 4. Paleobiogeographical Implications

*Nummulites* began to appear during Eocene in various parts of the world and the Palaeocene is marked by the absence of the genus *Nummulites*. *Paleonummulites* have a first occurrence in the latest Palaeocene (within NP9/P5a). Most of the genera studied first appeared in the late Thanetian (NP8-P4b-c) and were probably derived from a tightly coiled ancestors of *Paleonummulites* earlier in the Paleocene. *Nummulites* have broad distribution covering Europe from the Pyrenees to the north Atlantic, west and north Africa, Oman and Pakistan. *Paleonummulites thalicus* appears to be restricted to the eastern Tethys (Pakistan and Oman), while white *Planocamerinoides dantonius* is known from Italy, Afghanistan, Pakistan and Oman. Species attributed to *Paleonummulites* in the Caribbean de Cizancourt, 1948. *Nummulites* previously known from Nigeria, Libya, and the French and Spanish Pyrenees. A mixing of Tethyan and American fauna in North Africa is further supported by the report by Brun et al., (1982). The Indian Paleocene foraminiferal assemblage can therefore be seen to have marked similarity with those of Oman/Pakistan, especially with respect to *Nummulites* assemblage, but with and west Africa as well as Caribbean connection shown by the presence of *Nummulites margaretae*. *Discocyclinid* limestone member (dominantly shallow marine carbonates) of Palaeocene age crop out widely in Saidarpet and Thondaimanattam quarry sections and contain rich *Nummulites*. Several genera, especially *Assilina* and *Nummulites* are particularly useful for zoning Tethyan shelf sequences, where they are often tied to Nannoplankton and planktonic foraminifera zonation for Pondicherry area. *Nummulitoides canalifer* known from Pakistan, *N.*

*margaretae* known from Nigeria and Libya. *I. inaquilaterlis* and other species *N. tessieri* and *N. azilensis* from west Africa and the Pyrenees while specimens from Pakistan assigned to *Ranikothalia sinensis* clearly belong to the genus *Nummulitoides* (Butt, 1991). *Nummulites rockallensis* from the Rockall area (Van hinte and Wong, 1975) and from the porcupine seabight (Hennah, 1995) West of Ireland is also *Nummulitoides*. Amard and Blondeau (1979) have also illustrated some specimen assigned to *bermudezi* from Algeria that they may also be placed in *Nummulitoides*. The genus therefore has a broad distribution covering Europe from the Pyrenees to the North Atlantic, west and North Africa, Oman and Pakistan. *Nummulites* occur in association with *Discocyclinid* and a variety of extraordinarily well preserved trace fossils from the Late Palaeocene sediments of Saidarpet and Thondaimanattam quarry section of Pondicherry area.

## 5. Discussion and Conclusions

The Paleocene - early Eocene sequence of Pondicherry area is important because, this is the only known well-developed marine Paleocene - early Eocene outcrop yielded the richest and best preserved larger foraminifera *Discocyclina* is abundant in the marlstone. The *Nummulites* are recovered for the first time from the sediments exposed at Saidarpet and Thondaimanattam quarry sections of Pondicherry area. The biostratigraphy and paleobiogeographical implications of this *Nummulites* fauna are significant. The taxa were previously known only from Pakistan. Now it has a broad geographical distribution, covering Europe from the Pyrenees to the North Atlantic, west and North Africa, West Africa, Oman, Pakistan, Libya and western Ireland. The fauna therefore show marked mixing of taxa from Indian subcontinent, the Mediterranean/North Atlantic and West African region as well as including a taxon previously considered endemic to the Caribbean. The occurrence of *Nummulites* in association with *Discocyclinids* and trace fossils at Thondaimanattam quarry section and also in calcareous limestone in Saidarpet clearly indicate that the warm shallow water and more open marine environment as testified by the occurrence of *discocyclinids* become more abundant upward along with frequent *Nummulites*. The *Nummulites* illustrated herein come mainly from Karasur Formation and is thus dominantly Thanetian (NP8-NP9) in age close to the Paleocene-Eocene boundary. The whole succession from late Palaeocene to early Eocene was deposited by single cycle of transgression and regression in the Pondicherry Area.

## 6. Acknowledgement

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