

FORAMINIFERAL BIOSTRATIGRAPHY AND CORRELATION OF THE PALEOCENE SEQUENCE OF VRIDHACHALAM, CAUVERY BASIN¹

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ABSTRACT—A planktonic foraminiferal biostratigraphic zonation scheme is proposed for the first time for the Paleocene sequence of Vridhachalam. In all nineteen species of planktonic foraminifera are recorded, out of which twelve are recorded for the first time from this area. Three assemblage zones are recognised and correlated with various zonation schemes established in other parts of the world: Lower, *Globorotalia uncinata*—*Globorotalia pseudobulloides*—Assemblage Zone; middle, *Globorotalia pseudomenardii*—*Globorotalia pusilla laevigata* Assemblage Zone; and upper, *Globorotalia velascoensis*—*Globorotalia whitei* Assemblage Zone. The present studied sequence of Vridhachalam ranges from Upper Danian to Landenian.

INTRODUCTION

Blanford (1865) while describing the general geology and stratigraphy of Vridhachalam area (South Arcot Distt. Tamil Nadu), has referred only the presence of marine Cretaceous sequence, represented by Ariyalur Formation, overlain by continental Mio-Pliocene Cuddalore Sandstone. Almost similar sequence was described by him (1865) from Pondicherry

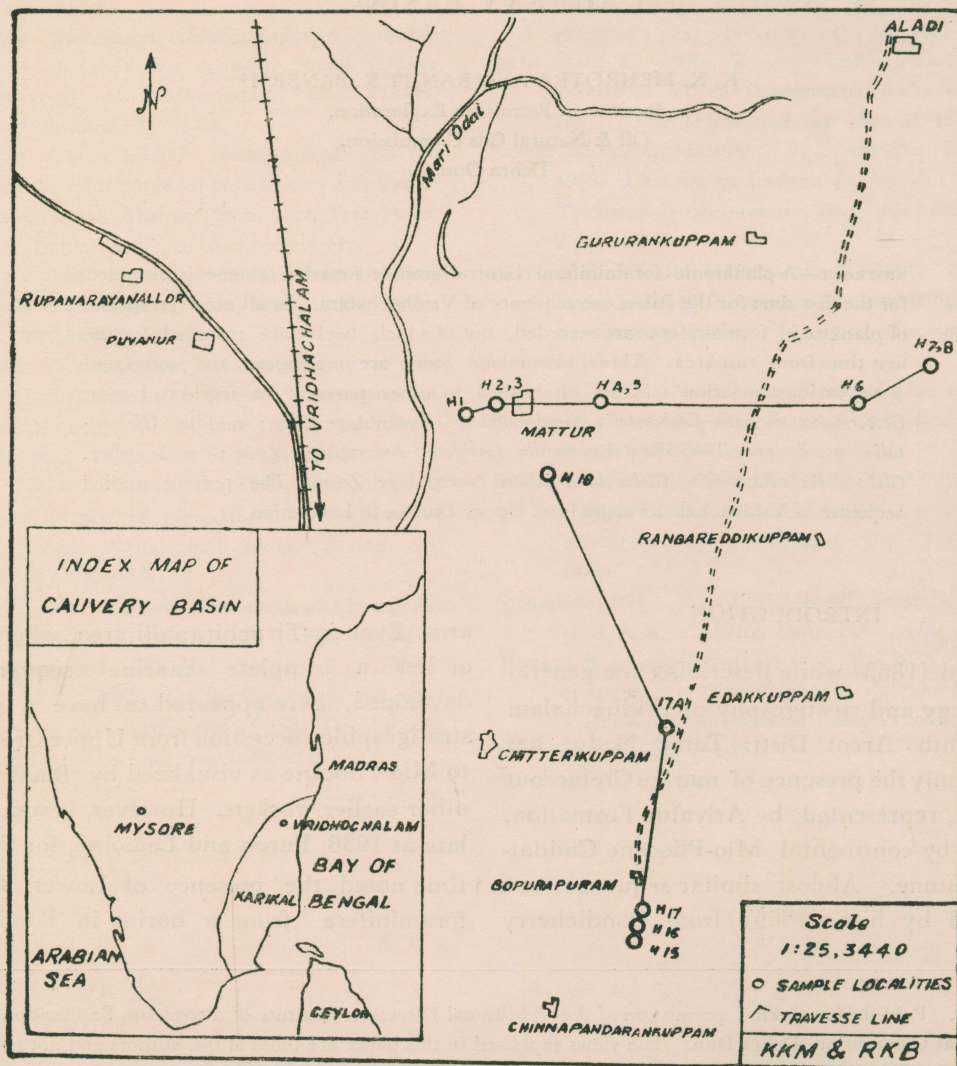
area. Even in Tiruchirapalli area, where more or less a complete marine sequence is developed, there appeared to have a gap in stratigraphic succession from Upper Cretaceous to Mio-Pliocene as visualized by Blanford and other earlier workers. However, it was only as late as 1938, Furon and Lemoine, for the first time noted the presence of Lower Tertiary foraminifera from a boring in Pondicherry

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area. The samples were later studied and assigned to Lower-Middle Eocene by Gowda (1964) and to Upper Paleocene to Early Eocene by Samanta (1968). The occurrence of Paleocene horizon in the outcrop sections of Pondicherry was, however, reported by Rajagopalan in 1964 and their foraminiferal biostratigraphic zones were established by him in 1965 and later modified in 1968.

The first report on the occurrence of Paleocene Foraminifera in the outcrop sections of Vrindhachalam was also made by Rajagopalan (1966). He recorded a planktonic foraminiferal assemblage from a siltstone exposed near Nachchiarpetai, about sixteen kilometers north of Vrindhachalam, comprising species like *Globigerina* cf. *G. trivialis*, *G. triloculoides*, *Globorotalia imitata*, *G. angulata*, *G.* cf. *G.*



Text Fig. 1—Sketch Map of Vrindhachalam Area showing sample localities.

chapmani, *Chiloguembelina midwayensis*, indicating a Paleocene age. Later in 1967, he identified a comparatively rich planktonic assemblage from a mudstone section in a dug well near Gopurapuram (seven kilometres northeast of Vridhachalam), to which a Middle to Upper Paleocene age was assigned; this assemblage differs considerably from those recorded by him from Nachchiarpettai. Except the planktonic species *Globigerina triloculinoides* (= *Subbotina triloculinoides*) and few others, which are common to both the sections, other species like *Globorotalia velascoensis*, *G. aequa*, *G. simulatilis*, *G. oclusa*, *G. pusilla laevigata*, *Chiloguembelina crinita* are recorded from Gopurapuram. Apart from these two notes by Rajagopalan, there is no other published record on micropaleontology of Paleocene horizon both from outcrop and subcrop sections in Vridhachalam, and no attempt has so far been made to work out the foraminiferal biostratigraphic zonation scheme.

With the intensification of the petroleum exploration activity in the Cauvery Basin in the south of Madras, a number of shallow wells and deep wells have been drilled by the Oil & Natural Gas Commission in Vridhachalam and other alluvial covered areas of Karikal, Kumbakonam, Manargudi, Thanjavur, etc., where Paleocene sequence is encountered. Out of more than half a dozen shallow wells drilled in Vridhachalam area, only those drilled near Rupnarayanalur, Gopurapuram, and Aladi are important and are referred here for their microfauna.

The aim of this paper is to report the planktonic assemblage from the Paleocene outcrop and subcrop sections of Vridhachalam and above mentioned areas and to work out their foraminiferal biostratigraphic zonation scheme. The surface samples were collected by

Banerji in 1969, in a north-south traverse from Gopurapuram towards Mattur in Vridhachalam area.

GENERAL FAUNAL CHARACTERISTICS

The outcrop samples from Rupnarayanalur and Gopurapuram are extremely rich in foraminifera having more than 10% of planktonic elements. These are invariably well developed and better preserved along with few reworked and ill-preserved forms. The calcareous benthonic foraminifera generally belong to the families—Nodosariidae, Nonionidae, Bolivinidae, Rotaliidae and Anomalinidae. Samples are generally rich in ostracodes. On the other hand, Aladi sequence is not so richly fossiliferous. Planktons are even rare and at times poorly preserved in this well. Among benthos, imperforate calcareous forms are sometimes more common in occurrence. The important planktonic species recorded from various recognized litho-units of these three wells are given below. The planktonic assemblage of outcrop sections of Gopurapuram has already been reported by Rajagopalan (1967) and is not repeated here.

PLANKTONIC ASSEMBLAGES

1. Rupnarayanalur Well

Litho-unit R4. Brownish yellow moderately hard, compact, fine to medium grained sandstone with bands of silty mudstone (Thickness ± 36 M).

FORAMINIFERA. *Globorotalia aequa* Cushman & Renz, *G. pseudomenardii* Bolli, *G. pusilla laevigata* Bolli, *G. perclara* Loeblich & Tappan, *G. elongata* Glaessner, *G. varianta* Subbotina, *Subbotina triloculinoides* (Plummer). *Globigerina linaperta* Finlay, etc.

Globorotalia pseudobulloides (Plummer), *Globigerinoides* cf. *G. daubjergensis* Bronnimann, present in this litho-unit appears to be reworked in nature.

Litho-unit R3. Calcareous silty claystone, dark grey in colour (Thickness ± 34 M).

FORAMINIFERA. *Globorotalia perclara* Loeblich & Tappan, *G. troelseni* Loeblich & Tappan, *G. variata* Subbotina, *Subbotina triloculinoides* (Plummer), etc.

Globorotalia pseudobulloides (Plummer), present in this litho-unit appears to be reworked in nature.

Litho-unit R2. Limestone hard, compact, fine grained, whitish grey in colour with bands of claystone (Thickness ± 50 M).

FORAMINIFERA. *Globorotalia tribulosa* Loeblich & Tappan, *G. perclara* Loeblich & Tappan, *Subbotina triloculinoides* (Plummer), *G. uncinata* Bolli, *G. pseudobulloides* (Plummer), and *Globigerinoides* cf. *G. daubjergensis* (Bronnimann).

Litho-unit R1. Alternations of sandstone and claystone (Thickness ± 60 M; Upper Cretaceous).

2. Gopurapuram Well

Litho-unit G4. Limestone, light grey to pale yellow in colour, with thin bands of sandstone (Thickness ± 15 M).

FORAMINIFERA. *Globorotalia pusilla laevigata* Bolli, *G. whitei* Weiss, *G. velascoensis* (Cushman) *G. aequa* Cushman & Renz, *Globigerina linaperta* Finley, etc.

Litho-unit G3. Alternations of calcareous medium grained sandstone and claystone (Thickness ± 95 M).

FORAMINIFERA. *Globorotalia pseudomenardii* Bolli, *G. cf. imitata* Subbotina, *G. aequa* Cushman & Renz, *G. velascoensis* Cushman, *G. whitei* Weiss, *G. convexa* Subbotina, *Globigerina linaperta* Finley, *Chiloguembelina midwayensis strombiformis* Beckmann, etc.

Litho-unit G2. Siltstone with alternate bands of finegrained sandstone and limestone (Thickness ± 70 M).

FORAMINIFERA. *Globorotalia aequa* Cushman & Renz, *G. velascoensis* Cushman, *G. whitei* Weiss, *G. pseudomenardii* Bolli, *G. pusilla laevigata* Bolli, *Chiloguembelina crinita* Glaessner, *Globigerina linaperta* Finley, etc.

Litho-unit G1. Claystone (Thickness ± 20 M). Devoid of foraminifera,

3. Aladi Well

Litho-unit A3. Alternations of medium grey, hard compact, fine to medium grained sandstone, and earthy silty claystone (Thickness ± 120 M). No foraminifera.

Litho-unit A2. Light grey medium to coarse grained, fossiliferous, micaceous sandstone in the upper part and dark grey, hard and compact claystone at the bottom (Thickness ± 50 M).

FORAMINIFERA. *Globorotalia velascoensis* Cushman, *G. whitei* Weiss, *G. aequa* Cushman & Renz, *G. elongata* Glaessner, *Globigerina linaperta* Finley,

Litho-unit A1. Medium light grey argillaceous siltstone at the top and greenish grey fine grained sandstone at the bottom (Thickness ± 30 M).

TABLE 1

GEOCHRONOLOGICAL UNITS		CORRELATION WITH			PROPOSED BIOSTRATIGRAPHIC ZONES IN VRIDHACHALAM (SUBCROP AND OUTCROP)	
		BIOSTRATIGRAPHIC ZONES OF BOLLJ, 1966	BIOSTRATIGRAPHIC ZONES OF PONDICHERRY OUTCROP (RAJAGOPALAN, 1968)	BIOSTRATIGRAPHIC ZONES OF KARIKAL SUBCROP (BANERJI, 1970)		
PALEOCENE	LANDENIAN	SPARNACIAN	<i>Globorotalia velascoensis</i>	<i>Globorotalia velascoensis</i>	<i>Globorotalia velascoensis</i> / <i>Globorotalia whitei</i>	
			<i>Globorotalia pseudomenardii</i>	<i>Globorotalia pseudomenardii</i>	<i>Globorotalia pseudomenardii</i>	<i>Globorotalia pseudomenardii</i> / <i>Globorotalia pusilla laevigata</i>
DANIAN (S. L.)	DANIAN (S. STR.)	MON-TAN	<i>Globorotalia pusilla</i>	<i>Globorotalia pusilla</i>	<i>Globorotalia whitei</i>	
			<i>Globorotalia angulata</i>			
		DANIAN (S. L.)	<i>Globorotalia uncinata</i>	<i>Globorotalia uncinata</i>	<i>Globorotalia uncinata</i>	<i>Globorotalia uncinata</i> / <i>Globorotalia pseudobullitoides</i>
			<i>Globorotalia trinidadensis</i>	<i>Globorotalia trinidadensis</i>	<i>Globigerinoides doubyergensis</i>	
			<i>Globorotalia pseudobullitoides</i>		-----?	

Correlation of Palaeocene Foraminiferal Zones of Pondicherry, Karikal and Vridhachalam.

TABLE 2
PLANKTONIC FORAMINIFERAL BIOSTRATIGRAPHIC ZONES RECOGNISED IN

ARIDHACHALAM SUB-CROP (PRESENT REPORT)	TAMPICO EMBAYMENT MEXICO (HAY, 1960)	INTERNATIONAL ZONATION SCHEME (BANDY, 1964)	GULF & ATLANTIC COASTAL PLAIN (BERGGREN, 1964)	ZONATION SCHEME BOLLI,—1966	GEO-CHRONO LOGICAL UNITS	P A L E O C E N E →		
						L A N D E N I A N		
						MON- TIAN S.S	DANIAN (S. L.)	
DANIAN (S.S)								
<i>Globorotalia velascoensis</i> — <i>Globorotalia whitei</i> Assemblage Zone	<i>Globorotalia velascoensis</i>	<i>Globorotalia velascoensis</i>	<i>Globorotalia velascoensis</i> Sub—Zone	<i>Globorotalia velascoensis</i>				
<i>Globorotalia pseudomenardii</i> — <i>Globorotalia pusilla laevigata</i> Assemblage Zone	<i>Globorotalia pseudomenardii</i>	<i>Globorotalia pseudomenardii</i>	<i>Globorotalia pseudomenardii</i> Sub—Zone	<i>Globorotalia pseudomenardii</i>				
<i>Globorotalia uncinata</i> — <i>Globorotalia pseudobulloides</i> Assemblage Zone	<i>Globorotalia uncinata</i> Sub—Zone	<i>Globorotalia pusilla pusilla</i>	<i>Globorotalia pusilla</i>	<i>Globorotalia pusilla pusilla</i>				
	<i>Globigerina</i> <i>daubjergensis</i> Sub—Zone	<i>Globorotalia uncinata</i>	<i>Globigerina daubjergensis</i>	<i>Globorotalia uncinata</i> <i>Globigerina spiralis</i>				

Vridhachalam Palaeocene Foraminiferal Zones and their equivalents in world stratigraphy.

FORAMINIFERA. *Globorotalia pseudomenardii* Bolli, *G. pusilla laevigata* Bolli, *G. velascoensis* Cushman, *G. whitei* Weiss, *G. aequa* Cushman & Renz.

DISCUSSION

The planktonic assemblage recorded from the above mentioned three subcrop sequences have many common elements with those reported by Rajagopalan (1966) from the outcrop and dug well sections. However, for the record, following twelve planktonic foraminiferal species are recorded for first time from this area:

Globorotalia pseudomenardii Bolli, *G. perclara* Loeblich & Tappan, *G. elongata* Glaessner, *G. varianta* Subbotina, *G. pseudobulloides* (Plummer), *G. troelseni* Loeblich & Tappan, *G. tribulosa* Loeblich & Tappan, *G. whitei* Weiss, *G. convexa* Subbotina, *Globigerina linaperta* Finlay, *Globigerinoides* cf. *G. daubjergensis* (Bronnimann) and *Chiloguembelina midwayensis strombiformis* Beckmann. *Globorotalia pseudomenardii* Bolli, *G. whitei* Weiss, and *G. elongata* Glaessner are quite abundant in their occurrence. All these species are well described and illustrated in the literature, hence they are not repeated here.

In the above recorded assemblage, most of the forms are long ranging, whereas, a few, otherwise, quite common in occurrence, have restricted stratigraphic range in many parts of the world. The latter include *Globorotalia pseudomenardii* and *G. pusilla laevigata*, generally considered to be restricted in range to *Globorotalia pseudomenardii* Zone (Upper Thanetian to Lower Sparnation of Bolli, 1966). The forms which appear before the first appearance of these two species, as recorded from Vridhachalam, are (with their established stratigraphic ranges in parenthesis)—*Subbotina triloculinoides* (*Globorotalia*

trinidadensis Zone to lowermost part of *Globorotalia pseudomenardii* Zone) and *Globorotalia velascoensis* (upper part of *Globorotalia pusilla pusilla* Zone to *Globorotalia velascoensis* Zone). A part from the species like *Globorotalia uncinata*, *G. pseudobulloides*, *Globigerinoides daubjergensis* which die out before the first appearance of *Globorotalia pseudomenardii* and *Globorotalia pusilla laevigata*, may be reworked in nature and might have been derived from the older sequence not penetrated by these wells. *Globigerinoides daubjergensis*, *Globorotalia perclara*, *Subbotina triloculinoides* etc. have been recorded from Danian-Montian of Atlantic and Gulf Coastal Paleocene formations (Loeblich & Tappan, 1957). On the other hand most of the other forms, as mentioned in the check list, have their first appearance along with *Globorotalia pseudomenardii*-*G. pusilla laevigata*; these are—*G. aequa*, *G. elongata*, *Chiloguembelina midwayensis strombiformis*. Very similar type of assemblage is described from Thanetian beds of Gulf Coastal regions (Loeblich & Tappan, 1957). In the upper sequence of Aladi well, the recorded assemblage is devoid of *Globorotalia pseudomenardii*, *G. pusilla laevigata*, but is characterized by the presence of *G. velascoensis*, *G. whitei*, *Globigerina linaperta* and few other long ranging forms.

Thus the entire assemblage can be divided into three groups, lower forms appearing below the first appearance of *Globorotalia pseudomenardii* and characterised by *Globorotalia uncinata*-*Globorotalia pseudobulloides*; middle-*Globorotalia pseudomenardii*-*Globorotalia pusilla laevigata* assemblage and upper-forms continuing even after the extinction of *Globorotalia pseudomenardii*-*Globorotalia pusilla laevigata*. Following three biostratigraphic zones in ascending order are thus delineated within the Paleocene subcrop sequence of Vridhachalam area. *Globorotalia uncinata*-

Globorotalia pseudobulloides Assemblage Zone; *Globorotalia pseudomenardii* - *Globorotalia pusilla laevigata* Assemblage Zone and *Globorotalia velascoensis* - *Globorotalia whitei* Assemblage Zone (Table 1).

Globorotalia chapmani Parr, *G. oclusa* Loeblich & Tappan, and *G. simulatilis* (Schwager), recorded by Rajagopalan (1967) from marlstone beds of Gopurapuram appears to be absent in the present studied subcrop sequences. Except *Globorotalia chapmani* which ranges up to Upper Eocene all other forms reported by him are restricted within Paleocene.

Almost similar assemblage of planktons are identified in the subcrop sequences of the regions lying outside Vridhachalam area but within the Cauvery Basin. The more important forms (including the reworked specimens) reported from these sequences are as follows :

1. MANARGUDI SUBCROP SEQUENCE

Globorotalia pseudomenardii Bolli, *G. uncinata* Bolli, *G. whitei* Weiss, *G. imitata* Subbotina, *G. perclara* Loeblich & Tappan, *G. esnaensis* (Le Roy), *G. elongata* Glaessner, *G. angulata abundocamerata* Bolli, *G. velascoensis* Cushman, *Globigerina mckannai* White, *Subbotina triloculinoides* (Plummer), *Quadrimorphina* sp., *Globocassidulina* sp., *Chiloguembelina wilcoxensis* (Cushman & Ponton), *C. midwayensis* (Cushman), etc.

2. KUMBAKONAM SUBCROP SEQUENCE

Globorotalia velascoensis Cushman, *G. pseudomenardii* Bolli, *Subbotina triloculinoides* Plummer, *Globigerina mckannai* White, etc.

3. THANJAVUR SUBCROP SEQUENCE

Globorotalia velascoensis Cushman, *G. angulata* (White), etc.

4. THIRUTTURAIPUNDI SUBCROP SEQUENCE

Globorotalia velascoensis Cushman, *G. aequa* Cushman & Renz, *G. angulata* (White), *G. uncinata* Bolli, *G. imitata* Subbotina, *Chiloguembelna* cf. *crinita* Glaessner, *Subbotina triloculinoides* (Plummer), *Globigerina mckannai* White, etc.

5. KARIKAL SUBCROP SEQUENCE

Globigerinoides daubjergensis (Bronnimann), *Globorotalia uncinata* Bolli, *G. angulata* (White), *G. aequa* Cushman & Renz, *G. elongata* Glaessner, *G. perclara* Loeblich & Tappan, *G. pseudomenardii* Bolli, *G. imitata* Subbotina, *G. pusilla laevigata* Bolli, *Subbotina triloculinoides* (Plummer), *Globigerina mckannai* White, etc.

GEOLOGICAL AGE AND CORRELATION

Based on the stratigraphical range of planktonic species, the lower, *Globorotalia uncinata*-*Globorotalia pseudobulloides* Assemblage Zone is tentatively correlated with *Globigerinoides daubjergensis* Zone--*Globorotalia whitei* Zone; middle *Globorotalia pseudomenardii*-*Globorotalia pusilla laevigata* Assemblage Zone with *Globorotalia pseudomenardii* Zone and *Globorotalia velascoensis*-*Globorotalia whitei* Assemblage Zone with *Globorotalia velascoensis* Zone of Unified Biostratigraphic Zonation scheme proposed by Banerji *et al.* (1969, 1970). Thus the present studied subcrop sequence from Vridhachalam ranges from Uppermost Danian to Landenian.

Very similar planktonic assemblage comprising species like *Globorotalia velascoensis*, *G. troelsenii*, *G. whitei*, *G. angulata*, *G. elongata*, *Globigerina linaperta*, etc. from Glauconitic marls, equivalent to Upper Paleocene (*Globorotalia velascoensis* Zone) in age and species like *Globorotalia pseudomenardii*, *G. cf. G. velascoensis*, *G. cf. G. tortiva*, *G. cf. G. varianta*, *G. aequa*, *G. angulata*, etc. from marly intercalations of clastic limestone unit (= *G.*

pseudomenardii Zone) has been recorded from the Kharatar wells drilled in Rajasthan (Sigal, 1965.)

On a regional basis, the studied Paleocene subcrop sequence of Vridhachalam is equivalent to that ranging from *Globorotalia pseudobulloides* Zone to *Globorotalia velascoensis* Zone of Bolli (1966). The lowermost *Globigerina eugibina* Zone of Bolli (1966) appears to be absent in Vridhachalam. Based on the faunal assemblage, zones may be correlated respectively with *Globigerina* Zone, *Globorotalia pseudomenardii* Zone and *Globorotalia velascoensis* Zone of Velasco Formation (Danian to Landenian), Tampico Embayment, Mexico (Hay, 1962) (Table 2). Planktonic foraminiferal zonation schemes for Paleocene, as proposed by Bandy (1964) and Berggren (1965), also compare very closely, with the present proposed assemblage zones of Vridhachalam. All these correlations are shown in Tables 1 and 2.

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