

STRATIGRAPHY, MICROPALAEONTOLOGY AND PALEOECOLOGY
OF THE UPPER CRETACEOUS AND LOWER TERTIARY FORMA-
TIONS OF PONDICHERRY, S.INDIA

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ABSTRACT

The Upper Cretaceous and Lower Tertiary rocks of Pondicherry, South India, contain three distinct lithological units: the Valudavur, the Trigonarca and the Nerinea formations. These three units which were known before as 'beds' are redefined. The Nerinea formation is divided into four informal lithological units: the Lower marlstone, the Algal limestone, the Discoeyclina limestone and the Upper marlstone. An analysis of the foraminiferal fauna of these rocks has led to the recognition of the following planktonic foraminiferal zones: the lower fossiliferous part of the Valudavur formation contains the Globotruncana lapparenti tricarinata Assemblage Zone. It is considered to be of Late Campanian age. The upper part of the Valudavur and the Trigonarca formations represent the Globotruncana gansseri Assemblage zone which is of Maestrichtian age. The Nerinea formation which is consi-

dered to range in age from Danian to Ypresian contains the Globigerina trinidadensis, the Globorotalia uncinata, the Globorotalia whitei, the Globorotalia velascoensis, the Globorotalia rex, the Globorotalia formosa formosa and the Globorotalia pseudoscutula Assemblage zones. Of these the Globorotalia whitei and the Globorotalia pseudoscutula zones are two new zones established in this section. The Globorotalia whitei zone is generally correlated with the Globorotalia pusilla pusilla and the Globorotalia pseudomenardii zones established in Trinidad. The Globorotalia pseudoscutula zone is correlated with the upper part of the Globorotalia aragonensis and the lower part of the Globorotalia palmerae zones of Trinidad. A new planktonic foraminiferal species Globorotalia pondicherriensis is described. The forms described by Loeblich and Tappan and Bolli as Globorotalia elongata are considered not synonymous with Globorotalia pseudoscutula var. elongata Glaessner and the new name Globorotalia loeblichi is given to these forms. A paleoecologic study of the foraminiferal faunas suggests that the sedimentation in this area took place under mid to outer neritic conditions.

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INTRODUCTION

Area under study: Limits, geological setting, nature of the country, vegetation etc.

The Upper Cretaceous and Lower Tertiary formations of Pondicherry, South India, occupy a low, level area of about forty sq. miles. The area lies between $11^{\circ} 56'$: $12^{\circ} 5'$ North latitude and $79^{\circ} 39'$: $79^{\circ} 52'$ East longitude, northwest of the erstwhile French town of Pondicherry on the East coast of India. The formations are bounded on the North and South by recent alluvium and on the East and West by the Cuddalore sandstones of Miocene age. By the erosion of the Cuddalore sandstones in the middle portion, the Upper Cretaceous and Lower Tertiary rocks have been exposed.

Much of the land is barren of wild vegetation; however, rock exposures are scanty, for most of the area is under cultivation and is occupied by irrigation lakes and ponds. There are no deep stream cuttings or anything of that kind to expose a good section of the rock formations except some small shallow irrigation wells which often expose rock sections up to a depth of about thirty feet.

The Pondicherry area is the northern-most of the three Cretaceous areas in the Madras State, India (Fig.1). The area on the South is the largest and occupies about

three hundred sq.miles near Trichinopoly. The rocks of this area are classified as follows: (Table 1a)

Cretaceous succession in Trichinopoly

Age	Stage
Danian to Maestrichtian	Niniyur
Maestrichtian	Ariyalur
Senonian	
Turonian	Trichinopoly
Cenomanian to Uppermost Albian	Uttattur

The middle area is near Vriddhachalam and occupies about fifty sq.miles. Here only the Ariyalur stage is represented.

Historical summary of previous work:

The earliest work on the Pondicherry area dates back to 1862 when Blanford described the Cretaceous rocks and recognised two distinct divisions; the lower, he named the Valudavur group and correlated it with the Uttattur of Trichinopoly. The upper one he found to be identical with the Ariyalur. Warth (1895) made a restudy of the groups and collected a large number of fossils. He distinguished six lithological horizons A, B, C, D, E and F, the three lower ones (A, B and C) constituting Blanford's Valudavur group and the upper three (D, E and F) corresponding to the Ariyalur group.

Kossmat (1897) who made a study of the fossils from this area concluded that the entire sequence should be correlated with the Ariyalur group. He classified the succession as follows on the basis of paleontological evidence:

Ariyalur	{ Nerinea beds	Horizon F
	{ Trigonarca beds	Horizon D and E
	{ Valudavur beds	Horizon B and C

Later works on this area are confined to reports of stray occurrences of some fossil forms. Furon and Lemoine (1939) reported the occurrence of Assilina granulosa and Discocyclina pratti from some borehole cores.

Fig. 1
The Cretaceous and Tertiary Rocks of
South India

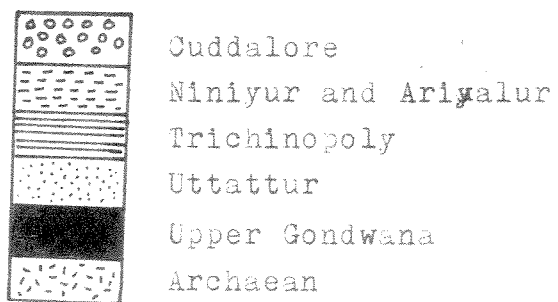
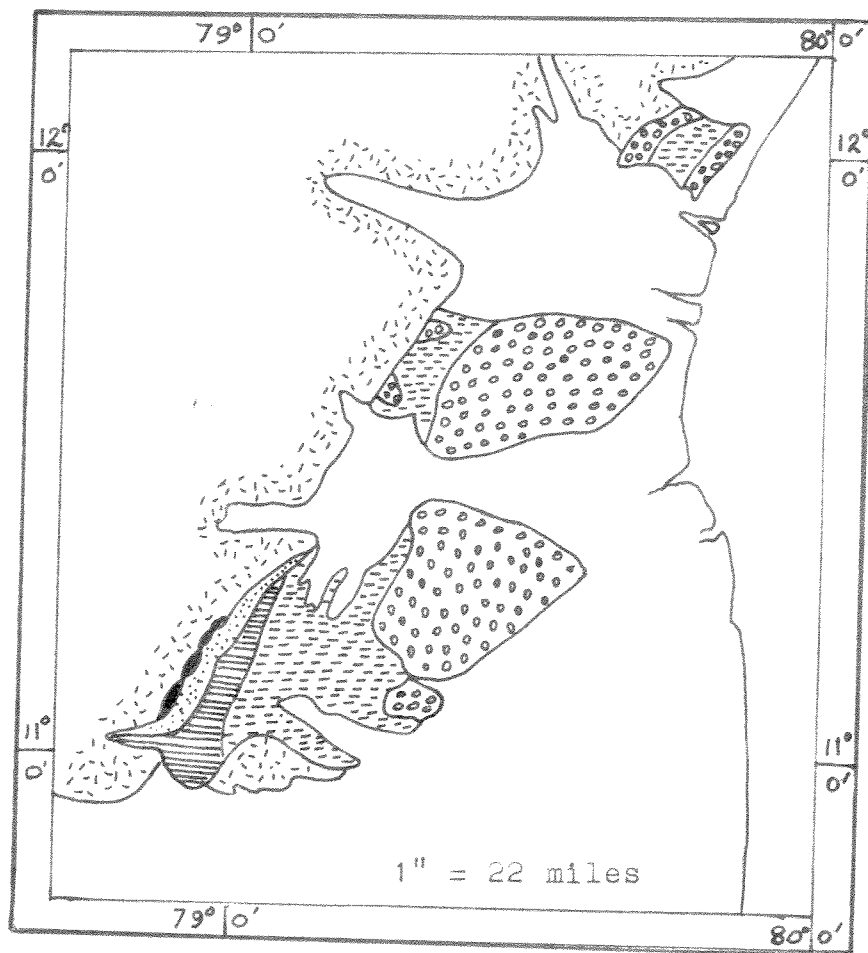


Table 1 b.

European stages	Upper Cretaceous stages in Trichinopoly	Warth 1895	Kossmat 1897	present paper	
Danian	Niniyur			Nerinea	Early Tertiary
Maestrichtian -- Senonian	Ariyalur	F	Nerinea		
		E	Trigonarca	Trigonarca	
		D			
		C	Anisoceras beds	Valudavur	
		B	(Valudayur of Blanford)		
		A			
Turonian	Trichinopoly				
Cenomanian -- Albian	Uttattur				

Rama Rao (1939) reported the occurrence of Nummulites and Discocyclina in certain limestones and suggested the existence of an Early Tertiary bed in the Pondicherry area.

Stratigraphy:

The writer recognises three distinct lithological units in the Upper Cretaceous and Lower Tertiary sequence of Pondicherry viz: the lower Valudavur formation, the middle Trigonarca formation and the Upper Nerinea formation. These three units roughly correspond to the three beds recognised by Kossmat on paleontological evidence viz: Anisoceras or Valudavur beds, Trigonarca beds and Nerinea beds. The name Valudavur has priority over Anisoceras and so named Valudavur formation. Though formational names normally go after names of localities, the names Trigonarca and Nerinea proposed by Kossmat are preserved in order to maintain the law of priority. The term 'beds' are changed to 'formation' to conform to the accepted code of stratigraphic nomenclature.

The Upper Cretaceous comprises only the two lower divisions of Kossmat: the Valudavur 'beds' and the Trigonarca 'beds'. The Nerinea beds are assigned a Lower Tertiary age. The three formations are apparently conformable. They extend over a strip of almost level

country seven to ten miles long and about four miles wide in a NE - SW direction. The dip of the rocks is about 2° SE. The Nerinea beds exposed at the Usteri canal section SE of Valudavur shows a dip of 5° SE.

The Valudavur formation which is the oldest in the sequence rests over the Archean crystalline rocks which are exposed a few miles further west of the area, the contact between the two, however, is not seen anywhere because of the overlying Cuddalore sandstones.

The Trigonarca formation has an interfingering relationship with the upper part of the Valudavur formation.

The Nerinea formation overlies the Trigonarca formation and follows the same general pattern of distribution in a NE - SW direction on the eastern side of the area. The lower part comprises two units: the lower marlstone and the Algal limestone. They do not contain Discocyclus. The upper part comprises two units: the Discocyclus limestone and the upper marlstone, both of which contain Discocyclus for the large part.

The Nerinea formation grades above into argillaceous sands and sandstones which are almost unfossiliferous. Cuddalore sandstones of Miocene age overlie these strata.

Purpose of the present study:

The present knowledge of the stratigraphy and age

limits of the Cretaceous - Tertiary rocks of Pondicherry are far from complete. The faunal characteristics of the Danian and its position in the time-stratigraphic scale were in a confused state in this part of India. Rama Rao (1956) goes to the extent of saying "it is not safe to attempt long distance correlations of the so-called Danian beds in different parts of the world, for in many cases we do not know what exactly their "Danian" is! In fact, recent studies in many of those areas have shown that the so-called "Danian" beds there are really part of the Lower Tertiary". The Pondicherry rocks are rich in their foraminiferal content. No attempt had been made to utilize foraminiferal microfaunas for bio-stratigraphic zonation and for long distance correlation of these rocks. The present study is one mainly on the smaller foraminifera found in the Upper Cretaceous and Lower Tertiary rocks of this area. It has been undertaken for the purpose of working out the stratigraphy of these rocks more completely, recognising planktonic foraminiferal assemblage zones, correlating these zones with those established outside India and deducing the paleoecology of these sediments. This foraminiferal study has enabled the writer to clear the misconceptions regarding the supposed Danian strata and to determine more precisely the age of the other formational

units in this region.

Material and methods:

During the summer months of 1960 and '61 samples were collected by the writer from all possible stratigraphic horizons in the area. Their localities were marked on a one inch topo sheet. Most of the samples were from either exposed well sections that were being dug at that time or from exposures at stream cuttings or from surface outcrops.

The material varies from soft easily friable argillaceous sand aggregates or marls to hard compact algal reef limestones.

A known quantity of each of the samples was taken for boiling. The more compact samples were first disaggregated in a mortar before boiling. They were all boiled with washing soda for about four hours and then treated in an ultrasonic disintegrator. The softer samples were treated for about twenty to thirty minutes under high frequency; the more compact materials were treated for several hours. By judicious adjustment of frequency and duration of treatment it is possible to obtain perfectly clean matrix free foraminiferal shells from the sediments. Overtreatment often results in the complete disintegration of the more thin walled shells.

The treated samples were again boiled for sometime and

then washed through a 200 or 250 mesh screen to remove the clay and silt size particles. After screening the samples were dried. The dried samples were treated with perchloroethylene to concentrate hollow tests of foraminifera. Twentyfour samples have yielded rich foraminiferal faunas. After preliminary identification of the species they were compared with the type specimens available at the Rutgers University Geology department and the United States National Museum at Washington D.C.

Paleoecologic studies were conducted in the following manner:

Foraminiferal number: The floated fraction of each sample was split to an easily countable portion and all the foraminifera in this portion were counted by using a mechanical counter. The total number of foraminifera in the whole floated fraction was computed. In a similar way the total number of foraminifera was found in the residual fraction also. Here material coarser than 20 mesh size was discarded as not disintegrated. This quantity was deducted from the original weight taken for washing. Foraminiferal number for the sample was determined by combining the two quantities and dividing it by the weight of material washed.

Planktonic/Benthonic ratio: A representative portion of the floated material was spread evenly over a gridded

plate and random countings of over three hundred individuals, both benthonic and planktonic, were made. Similar countings were made for the residual fraction also and then the percentage of planktonics for the entire sample computed.

Relative abundance of species: Over two hundred individuals each of planktonic and benthonic were counted and the results tabulated as shown in tables 5 and 6.

Acknowledgments:

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species. Dr. Richard A. Cifelli kindly extended the facilities of the United States National Museum for comparisons with the type specimens of foraminifera. Camera lucida illustrations of the foraminifera were made by Mr. Ansis G. Kaneps.

Depositories: Holotypes and paratypes of the new species and some selected hypotypes of the planktonic Foraminifera are deposited in the United States National Museum foraminiferal collections in Washington D.C. Faunal slides, a complete set of hypotype specimens and paratypes are deposited in the collections of the Department of Geology of the Rutgers University, New Brunswick, U.S.A. These depositories are abbreviated in the systematic descriptions as (USNM) - United States National Museum and (R) - Rutgers University.

VALUDAVUR FORMATION

The Valudavur formation occupies a major portion of this area in areal extent. It comprises, according to the writer, the 'A' and the 'B' horizons of Warth. It is for the most part composed of fine to medium and coarse grained quartz sandstones and sands often felspathic and slightly calcareous with concretions of limestones, sandy clays and mudstones. Boulders of conglomeratic sandstones are found near the base of the formation (locality PK 2). The thickness of the Valudavur formation is estimated to be approximately 550 feet. In the upper part, the sands and sandstones of the Valudavur formation interfingers with the Trigonarca formation.

Fauna:

Kossmat (1897) recorded a rich ammonite fauna in this formation. He named this unit as Anisoceras beds after the ammonoid genus Anisoceras which he found in abundance.

The Valudavur formation has yielded a typical Late Campanian and Maestrichtian planktonic foraminiferal fauna from PK 6 and 7 localities (Table 2 a). The vertical distributions of these species in Trinidad and Denmark are given in Tables 2 b and c respectively. The planktonic foraminiferal fauna of PK 6B contains among others Globotruncana stuartiformis, Globotruncana fornicata, Pseudotextularia elegans and Pseudotextularia fructicosa. Higher in the section (PK 6A and

truncana gansseri, Globotruncana stuartiformis and Globotruncana arca assemblage (PK 6A and PK 7) may be assigned a Maestrichtian age and referable to the Globotruncana gansseri zone established in Trinidad by Bolli.

Ecology:

Results of the analysis of the foraminiferal fauna from the Valudavur formation are given in table 5. The fauna is characterised by a very low foram number and a fairly high percentage of planktonics. The benthonic foraminifera are very poorly represented. Among those present there is a high frequency of the genus Anomalinoides belonging to the family Anomalinidae. The frequency of genera belonging to the following families is much less:

Lagenidae (Marginulina, Saracenaria, Robulus)

Polymorphinidae (Guttulina)

Rotaliidae (Gyroldinoides)

Buliminidae (Loxostomum)

Arenaceous foraminifera are almost completely absent. The number of planktonic species is quite appreciable but poor in individuals. The planktonic / benthonic ratio is 36 to 40%. A low foram number is usually attributable to rapid deposition, but here the thickness of the formation is not so large as to warrant any such interpretation.

The entire thickness of the whole Cretaceous and Early Tertiary sequence is estimated to be less than 1000 feet. The geological time involved in the deposition of these sediments is from Campanian to Ypresian; for such a length of time the thickness is not much. The low foram number is most probably attributable to solution effects and leaching.

The planktonic/benthonic ratio, in this case, is not a reliable index for depth determinations in view of the very low foram number which is possibly due to effects of solution and leaching. However, the nature of the benthonic fauna indicates outer neritic environs.

TRIGONARCA FORMATION

The writer considers horizons C, D and E of Warth to comprise the Trigonarca formation. This is characterized by beds of shell limestones one to two feet thick interbedded with the yellowish white argillaceous sandy material of the Valudavur formation. The shell limestone is whitish or bluish in color in the northern part and in the southern part it is more a fine grained calcareous shell sandstone of brown color. This formation is easily recognizable; it extends all the way from Mettuveli through Royapuduppakkam up to Koluvari in a NE - SW trend.

Kossmat's Trigonarca beds comprise only the D and E

horizons of Warth. He includes the 'O' horizon of Warth under Valudavur 'beds'. There seems to be no justification for this as there is no lithological difference between the C and D and E horizons. Further, all the localities mentioned by Kossmat under those three horizons lie within a long narrow strip of country with a NE - SW trend. This area is made up of uniform lithology. The thickness is estimated to be about 90 feet.

Fauna:

Kossmat states that ammonites are very rare in this formation whereas Nautilus is frequently found and among the bivalves certain genera especially Ostrea and Trigonarca occur abundantly.

The Trigonarca formation has yielded foraminifera in only one locality (PK 8). A few diagnostic Maestrichtian planktonic foraminifera are present but very rare. Among the benthonic forms Quinqueloculina is of common occurrence.

Table 6 gives the list of planktonic and benthonic foraminifera found in the Trigonarca formation.

Correlation and age:

The Trigonarca formation which overlies the Valudavurs represents the latest phase of Cretaceous sedimentation in this area. The few planktonic foraminifera that are present in this formation indicate a Maestrichtian age.

Such diagnostic latest Cretaceous planktonic foraminifera like Globotruncana stuarti and Abathomphalus mayaroensis are absent in this formation. It is, therefore, questionable whether the Trigonarca formation represents the uppermost Maestrichtian or not.

Ecology:

Results of the analysis of foraminiferal fauna from the Trigonarca formation are included in table 5. The fauna is characterised by an almost negligible foram number of 10, a low planktonic/benthonic ratio of about 12%, frequent occurrence of individuals belonging to the *Milliolidae* and *Anomalinidae*, arenaceous forms comprising about 5% of the fauna and a fair representation of the family *Lagenidae*. The faunal composition suggests depth conditions of 100 to 200 feet. Thus a shallowing of the depositional basin after deposition of the Valudavurs is indicated.

Table 2 a

Distribution of Valudavur and Trigonarca Planktonic foraminiferal species in Pondicherry.

Species	Valudavur		Trigon- arca
	Gt.lap. tricari nata zone	Gt. gansseri zone	
<u>Heterohelix carinata</u>			
<u>Globotruncana linneiana</u>			
<u>Gt. fornicata</u>			
<u>Heterohelix globulosa</u>			
<u>H. striata</u>			
<u>Gt. stuarti stuartiformis</u>			
<u>Rugoglobigerina rugosa</u>			
<u>Gt. cf tricarinata</u>			
<u>Pseudoglobulina excolata</u>			
<u>Heterohelix sp.</u>			
<u>Heterohelix planata</u>			
<u>Planomalina messinae</u>			
<u>Gümbelitria cretacea</u>			
<u>Pseudotex. fructicosa</u>			
<u>Pseudotex. elegans</u>			
<u>Globotruncana contusa</u>			
<u>Gt. mariei</u>			

Table 2 a

Distribution of Valudavur and Trigonarca Planktonic
foraminiferal species in Pondicherry continued.

Species	Valudavur		Trigon- arca
	Gt.lap. tricari nata zone	Gt. gansseri zone	
<u>Globotruncana arca</u>			
<u>Gt. gagnebini</u>			
<u>Gt. marginata</u>			
<u>Gt. gansseri</u>			
<u>Gt. subcircumnodifer</u>			
<u>Praeglobotruncana petaloidea</u>			
<u>Rugoglobigerina pustulata</u>			
<u>R. rotundata</u>			
<u>Heterohelix pulchra</u>			

Table 2 (b)

Vertical distribution of Valudavur Planktonic
foraminiferal species in Trinidad.

Planktonic foraminifera.	Planktonic foraminiferal zones				
	Lower zones	<u>Globotruncana</u> <u>stuarti</u>	<u>Globotruncana</u> <u>lapparenti</u> <u>tricarinata</u>	<u>Globotruncana</u> <u>gansseri</u>	<u>Abathomphalus</u> <u>mayeroensis</u>
<u>Globotruncana fornicata</u>					
<u>G. arca</u>					
<u>G. stuarti</u> group					
<u>G. gansseri</u>					
<u>G. contusa</u>					
<u>G. gagnebeni</u>					
<u>Rugoglobi. pustulata</u>					
<u>R. rugosa</u>					
<u>R. r. rotundata</u>					
<u>Planom. messinae</u>					
<u>Pseudogüm. excolata</u>					
European stages	Turon. - Santon.	Campanian	Maestrichtian		

Table 2 (c)

Vertical distribution of Valudavur planktonic
foraminiferal species in the Maestrichtian of Denmark.

Planktonic foraminifera	Maestrichtian	
	Lower	Upper
		<u>P.ele-</u> <u>gans.</u>
<u>Heterohelix striata</u>		
<u>Pseudotextularia fructicosa</u>		
<u>P. elegans</u>		
<u>Praeglobotruncana petaloidea</u>		
<u>Planomalina messinae</u>		
<u>Globotruncana arca</u>		
<u>G. contusa</u>		
<u>G. mariei</u>		
<u>G. tricarinata</u>		
<u>G. gansseri</u>		
<u>Rugoglobigerina rugosa</u>		
<u>R. pustulata</u>		

Table 3

Distribution of Valudavur benthonic foraminiferal
species in Pondicherry.

Species	Localities		
	PK 6 B	PK 6 A	PK 7
<u>Anomalinoides navarroensis</u>	X	X	X
<u>Buliminella</u> sp.		X	
<u>Epistominella minuta</u>	X	X	
<u>Gaudryina</u> sp.		X	
<u>Gyroidina octocamerata</u>		X	
<u>Lingulina</u> sp.		X	X
<u>Loxostomum plaitum</u>	X	X	X
<u>Marginulina bullata</u>			X
<u>Nodosaria latejugata</u>			X
<u>Nodosaria obscura</u>			X
<u>Oolina</u> sp.		X	X
<u>Rectoglandulina</u> sp.			X
<u>Saracenaria triangularis</u>		X	?
<u>Tappanina selmensis</u>			X

Table 4

Vertical distribution of Valudavur benthonic foraminiferal species outside India.

	Upper Cretaceous of North America	Cretaceous of Egypt	Cretaceous of Japan	Paleocene of North America	Paleocene of Sweden	Eocene of North America
<u>Anomalinoidea navarro-</u> <u>ensis</u>	X					
<u>Epistominella minuta</u>				X		X
<u>Gyroldina octocamerata</u>				X	X	X
<u>Lagena sulcata</u>	X	X		X		X
<u>Loxostomum plaitum</u>	X					
<u>Marginulina bullata</u>	X		X			
<u>Marginulinopsis</u> <u>silicula</u>	X					
<u>Nodosaria latejugata</u>				X		X
<u>N. obscura</u>	X		X			
<u>Saracenaria triangularis</u>	X	X	X	X		X
<u>Tappanina selmensis</u>	X			X		X

Table 5

Relative abundance of Genera, Species and Individuals from benthonic foraminiferal families in the Valudavur and Trigonarca formations.

Families	Valudavur						Trigonarca		
	PK 6 (A)			PK 7			PK 8		
	Zone of <u>Globotruncana gansseri</u>								
	FN 180			FN 233			FN 10		
	Genera	Species	% indiv.	Genera	Species	% indiv.	Genera	Species	% indiv.
Lagenidae	4	4	8	1	1	2	5	6	24.3
Polymorphinidae	1	1	2						
Buliminidae	2	2	6	1	1	4			
Rotaliidae	1	2	16				1	1	1.4
Anomalinidae	2	2	68	2	3	94	2	4	34.3
Silicininidae							1	1	4.3
Miliolidae							1	1	34.3
Textularidae							1	1	1.4
Benthonics counted	50			50			70		
Planktonics %	36%			40%			12.5%		

Table 6

List of Planktonic and Benthonic foraminifera in
the Trigonarca formation at locality PK 8.

Globotruncana stuarti stuartiformis

Heterohelix striata

Pseudotextularia elegans

Pseudotextularia fructicosa

Anomalinoides navarroensis

Lagena sulcata ?

Lingulina sp.

Marginulinopsis cf M. sillicula

Marginulina sp.

Miliammina sp.

Oolina sp.

Quinqueloculina sp.

Rectoglandulina sp.

Saccammina sp.

Saracenaria triangularis

Spiroplectammina sp.

NERINEA FORMATION

The so called Nerinea beds of Kossmat (1897) comprises the 'F' horizon of Warth (1895) and is composed of "yellowish, very calcareous coarse grained sandstone, which contains here and there limestone nodules and forms the only continuous hard bed in the Pondicherry Cretaceous". Kossmat obviously refers to the persistent lithological horizon of hard compact algal limestone extending in a NE - SW direction for a distance of about eleven miles with a width of about half a mile and containing Disco-cyclina in the upper part. The Nerinea formation of the writer comprises something more than this hard bed. It includes also the underlying and overlying beds of marlstones which have hitherto remained unknown. The estimated approximate thickness of the Nerinea formation is 185 feet.

Lower marlstone:

The lower marlstone beds of the Nerinea formation overlies the Trigonarca formation. They are composed of friable or compact, fine to medium grained, yellowish brown sandy marlstone beds in the lower part (localities PT 1 and PT 2) and highly friable soft, pale yellow marlstones in the upper part (PT 3). The thickness of this unit as recorded from surface and well exposures is found to be about 17 feet.

Algal limestone:

This forms the lower part of the so called Nerinea beds of Kossmat. It is a white or brown, hard compact, algal limestone exposed at localities PT 3, PT 4 and PT 5. Thin sections of these limestones show that the material is almost wholly composed of thin encrusting coralline algae. The approximate thickness of this unit as measured in well sections is 30 feet.

Discocyclina limestone:

This forms the upper part of Kossmat's 'Nerinea beds'. It is a brown hard compact Discocyclina bearing limestone. Weathered surfaces of this material are heavily loaded with the small thin discoidal tests of Discocyclina, easily detectable by the naked eye. Thin sections show the presence of Discocyclina, Camerina ? and algae.

Upper marlstone:

This forms the uppermost part of the Nerinea formation exposed at localities PT 13 to PT 19. It is composed of soft friable yellowish brown marlstone. The uppermost part of this member does not contain Discocyclina.

Fauna:

The following is the list of macrofauna recorded by Kossmat from the 'Nerinea beds':

Nautilus (Aturia) delphinus, Nautilus danicus, N.serpentinus, N.sphoericus, N. tamulicus, Nerinea sp., Cyclo-

lites conoidea, Caryophyllia arcotensis and Turbinolia arcotensis. The absence of any ammonoides and the presence of a form like Aturia is noteworthy in this collection.

Foraminifera:

The Nerinea formation of Pondicherry has yielded a rich foraminiferal fauna in a very good state of preservation. Table 7 gives the list of benthonic species recorded and their distribution. Table 8 shows their vertical range in some foreign localities. Though most of the benthonic forms have a long vertical range and are not very reliable as zonal markers, a few as for instance Aeolostreptis marylandicus Nogan, which has been recorded in the basal Aquia and Brightseat formations of U.S.A both of which are of Danian age, occurs in the basal beds of the Lower marlstones which are considered to be of Danian age. This species does not occur in any lower or higher zone. It is also to be noted that most of the benthonic species occurring in this area have a very wide geographical distribution in strata of comparable age.

Table 9 gives the list of planktonic foraminifera and their distribution in the Nerinea formation. The absence of Globorotalia pseudomenardii in the Algal limestone and Discocyclina limestone beds is probably due to

ecologic control. Table 10 shows the ranges of *Nerinea* planktonic species in Trinidad.

Larger foraminifera:

Kossmat recorded the occurrence of Orbitoides and Amphistegina sp. ? in the *Nerinea* beds. These were later recognised as Discocyclina and Nummulites respectively by Rama Rao (1939). Rama Rao, Narayan Rao and Nagappa (1940) recorded the occurrence of Nummulites cf thalicus Davies, from a supposed Eocene bed in the Pondicherry area. This must obviously be from the Discocyclina limestone beds of the *Nerinea* formation.

Thin sections of samples from the Discocyclina limestone were examined by Dr. Cole. He is of opinion (personal communication) that the specimens have a general resemblance to Discocyclina archiaci, a European species mentioned by authors as occurring in the Ranikot, and possibly in the Laki of northwestern India and that they also resemble D. pygmaea described from Timor in strata assigned to the Ypresian. He has also noted the presence of a small thick walled Camerina like form.

Ostracodes:

The writer (1962) noted the occurrence of Ostracoda in this area and described seven new species and one new genus from the Upper marlstone beds of ^{the} *Nerinea* formation.

Algae:

Table 11 gives the list of algal species recorded by Dr.J.Harlan Johnson from the Nerinea formation (algal limestones).

Correlation and age:

The rich foraminiferal fauna of the Nerinea formation lends itself for its classification into several planktonic foraminiferal assemblage zones. These zones form an almost complete sequence. They correlate well with the zones recognised in Trinidad for the Paleocene and Lower Eocene succession.

The basal part of the Lower marlstone beds contains Globigerina daubjergensis, Globorotalia pseudobulloides, G. trinidadensis and G. compressa and is equivalent to the Globigerina daubjergensis zone of the type Danian of Denmark and the Globorotalia trinidadensis zone recognised in Trinidad by Bolli. This zone is exposed in locality PT 1.

Higher beds in this sequence exposed at locality PT 2 contain a better developed planktonic fauna with more genera and species. Among others Globorotalia uncinata is present. Globigerina daubjergensis is absent. This zone is referable to the upper part of the Globorotalia uncinata assemblage zone of Trinidad.

The upper part of the Lower marlstone beds and the

Algal limestones contain a planktonic fauna very close to the faunal assemblages of the Globorotalia pusilla pusilla and Globorotalia pseudomenardii zones of the Lizard Springs formation of Trinidad. However, the most dominant element of the planktonic fauna in the upper part of the Lower marlstones is Globorotalia whitei and so, for convenience of biostratigraphic work in this region, this zone is named the Globorotalia whitei assemblage zone. This zone is found at locality PT 3.

The upper part of the Nerinea formation contains a distinct planktonic fauna somewhat different from that of the lower. Several new planktonic elements are introduced. Globorotalia whitei becomes extinct. There is a sudden outburst of Discocyclina in great abundance. The Discocyclina limestone contains planktonic faunal assemblages close to that of the Globorotalia velascoensis and Globorotalia rex zones of the Lizard Springs formation of Trinidad. The Globorotalia velascoensis zone is generally considered to belong to the latest Paleocene. In the Nerinea formation Globorotalia velascoensis first appears at the base of the Discocyclina limestone and continues all the way up to the top of the Upper marlstone beds. The planktonic faunal assemblage of the G. velascoensis zone is more akin to that of the higher zones than to

that of lower zones. Hence the writer is inclined to place this zone at the base of the Eocene and does not favour its inclusion in the Paleocene as others have done (Bolli 1957, Loeblich and Tappan 1957). The Globorotalia velascoensis zone is found at localities PT 7 to PT 9. The Globorotalia rex zone is found at PT 10 and PT 11.

The Upper marlstone beds are considered Ypresian in age. It has two distinct planktonic faunal zones, the lower one containing Globorotalia formosa gracilis, G. formosa formosa and G. aragonensis is considered equivalent to the G. formosa formosa zone and to the lower part of the G. aragonensis zone of the Upper Lizard Springs formation of Trinidad. This zone is found at localities PT 13 to PT 16.

In the upper strata of the Upper marlstones Globorotalia pseudoscitula is the dominant element of the planktonic fauna. In addition it contains G. formosa gracilis, G. aragonensis and forms close to some middle Eocene faunal elements as G. spinulosa and G. densa. This zone is considered equivalent to the upper part of G. aragonensis and lower part of G. palmerae zones of Trinidad. This zone is found at PT 17 to PT 19.

Ecology:

Results of foraminiferal analysis of the Nerinea

formation are given in table 12. The foraminiferal fauna is characterised by a low to moderately high foram number, planktonic/benthonic ratio varying from 3.5 to 55% and a great number of genera and species. The almost complete absence of arenaceous forms and such genera like Elphidium, Rotalia etc. rules out the possibility of nearshore or inner continental shelf conditions of deposition. The abundance of genera and species of benthonic foraminifera is diagnostic of outer continental shelf (60 - 100 m $\pm$) and upper continental slope (100 - 1000 m $\pm$) but the faunal characteristics of the Nerinea formation are certainly not diagnostic of the latter realm. Abundance of species belonging to the genera Chilostomella, Pullenia and such spinose and ornate forms of Bulimina like Bulimina aculeata and B. spicata would indicate water depth conditions of more than 200 meters. In the Nerinea formation though a few samples have yielded some Chilostomella, Pullenia quinqueloba and Bulimina midwayensis which is morphologically akin to B. aculeata, they are of scattered occurrence only and should not be taken to indicate great depths. The Nerinea benthonic fauna is characterised by high percentages of individuals and high frequencies of genera of the following families:

Anomalinidae (Anomalinoides, Cibicides)

Rotalidae (Osangularia, Alabamina, Gyroidinoides,
Eponides)

Buliminidae (Bulimina)

Uvigerinidae (Pseudouvigerina)

The Lagenid genera and species are well represented, however, as individuals they are generally poor. This benthonic assemblage is suggestive of outer neritic conditions.

The great development of encrusting coralline algae particularly in the algal limestone beds suggests a photic zone environment which is obviously not deeper than 200 meters. Further the occurrence of Discocyclina in great abundance is not indicative of great depths. It is, therefore, concluded that the Nerinea formation was formed under neritic depth conditions ranging from 60 - 150 meters.

The results of the faunal analysis show that in the Lower Nerinea the percentage of individuals of the genus Discocyclina is greater than in the upper. At the same time the planktonic/benthonic ratio is somewhat lower when compared with the upper. From this it should be inferred that the Upper Nerinea was deposited under slightly deeper conditions than the lower.

Discussion

A part of the eastern continental edge of South India was under the sea during the later part of the Cretaceous period when sediments were deposited over the Archaean crystallines. In the Pondicherry area Cretaceous marine sedimentation commenced at a much later time than in the Trichinopoly area. From evidences available at present it appears that marine waters extended over the Pondicherry region during the Late Cretaceous period (Late Campanian or Early Maestrichtian) and converted this Archaean terrain into a continental shelf area of deposition. The earlier part of Upper Cretaceous sedimentation (Valudavur) appears to have taken place under depth conditions ranging from 60 to 100 meters and the later part (Trigonarca) under shallower depths of 30 to 70 meters. Then again during the Early Tertiary time the area seems to have gone under deeper waters, deposition of the Nerinea sediments having taken place at depths of 60 to 150 meters.

The earlier sedimentary deposits (Valudavur) of this area are mostly of a clastic nature. The later ones (Trigonarca and Nerinea) are dominantly calcareous. The great development of calcareous algae and Foraminifera during the Early Tertiary times have obviously contributed a large part to the formation of the carbonate deposits of the Nerinea formation.

The thickness of the Cretaceous section in this area is estimated to be about 640 feet and that of the Lower Tertiary 185 feet. It is evident that the time involved in the deposition of the Cretaceous sediments is much less than that of the Tertiary. It is therefore to be inferred that the Early Tertiary sedimentation was much slower than the Cretaceous.

The planktonic foraminiferal fauna of the Nerinea formation is well developed and lends itself for comparison with that of other regions. It is a typical tropical fauna characterised by the abundance of genera and species. Globorotalid species, particularly the angular keeled forms are better represented than the Globigerinids in the later part of the Early Tertiary. The converse appears to be true for cold temperate faunas: In the Early Eocene (Ypresian) planktonic foraminiferal fauna of Denmark and Northwestern Germany described by Berggren (1960) angular and keeled Globorotalids are absent. The fauna itself is characterised by a limited number of genera and species. In the Atlantic Coastal Plain deposits also the keeled forms of Globorotalia are not common.

As found in modern seas the distribution of certain fossil forms appears to be restricted to particular climatic belts and water masses. The highly ornate Globorotalia velascoensis which occurs in the Caribbean area,

Trinidad, Pacific Sea Mounts, Tethyan region, South India etc. all in one climatic belt, is not present in the U.S. Atlantic Coastal Plain. Instead there occurs the less ornate form Globorotalia acuta. Globorotalia pusilla pusilla, Globorotalia whitei and Globorotalia broeder-manni which occur in areas that lie in the tropical belt have not been recorded from the more temperate U.S. Atlantic Coastal Plain.

The planktonic foraminiferal fauna of the Nerinea formation has a general resemblance to the Tethyan fauna of similar age recorded from Europe and the fauna from Russia. Globorotalia marginodentata Subbotina is a form common in these regions. Forms almost identical to this are found in the Pondicherry material as variants in the population of Globorotalia rex. Globorotalia marginodentata is not present in the American region or Trinidad. Globorotalia nammalensis (Haque) is a common element of the planktonic fauna between the Pondicherry area and the Tethyan zone of Salt Range, Pakistan.

The Lizard Springs fauna of Trinidad compares well with the Nerinea fauna, both regions being in the same latitude. However, there are differences in the vertical distribution of some of the species. One of the most striking differences is in the range of Globorotalia pseudomenardii which is much greater in South India than in

Trinidad. This species is not, therefore, chosen as a zonal marker for the South India section. Similarly the zone of Globorotalia aragonensis is not clearly differentiated but instead the new zone of Globorotalia pseudo-scitula is quite distinctive. Globorotalia velascoensis which is restricted to the Paleocene in Trinidad occurs throughout the Lower Eocene in South India.

Globorotalia crater Hornibrook (not Finlay) is a form close to Globorotalia velascoensis occurring in the Lower Eocene of New Zealand. It was thought that Globorotalia velascoensis was a Paleocene form and Globorotalia crater belonged to Eocene. This does not appear to be true. In the present population of Globorotalia velascoensis there are forms identical with Globorotalia crater. It appears that Globorotalia velascoensis which made its appearance in Late Paleocene restricted itself to certain tropical waters as the South India region during the Early Eocene, at the same time developing Globorotalia crater like forms which alone migrated to higher latitudes as New Zealand.

Thus it is clear that in attempting regional correlations with the aid of planktonic Foraminifera, ecologic factors affecting their distribution should be taken into consideration. Tropical faunas are much more complex and varied than the temperate and cold water faunas and as a result the student of tropical planktonic Foraminifera is

confronted with problems of taxonomy to a greater extent.

From the present study it is observed that planktonic Foraminifera offers greater avenues of utilization than for just purposes of correlation such as paleoclimates, movements of water masses, migratory routes of faunas etc. etc.

Table 7

Occurrence of Nerinea benthonic foraminiferal species
in Pondicherry. (Numbers refer to PT localities)

	Lower marlstones			Algal lime- stones	Discocyclina limestones		Upper marlstones	
	1	2	3		7-9	10-11	13-16	17-20
<u>Aeolotrptis</u> <u>marylandicus</u>	x							
<u>Alabamina</u> <u>midwayensis</u>	x	x	x	x	x	x	x	x
<u>Allomorphina</u> <u>halli</u>		x	x	x	x		x	x
<u>Anomalinoides</u> <u>acuta</u>	x		x	x	x			
<u>A. longi</u>		x		x	x	x	x	
<u>A. umbonifera</u>	x	x			x		x	x
<u>Aragonia</u> <u>compressa</u>				x				
<u>Bolivina</u> <u>crenulata</u>		x						
<u>Bulimina</u> <u>midwayensis</u>		x		x				
<u>B. ovata</u>			x	x	x	x	x	x
<u>B. referata</u>	x	x	x	x	x	x	x	x
<u>B. virginiana</u>						x	x	x
<u>Chilostomella</u> <u>sp.</u>							x	x
<u>Chrysalogonium</u> <u>arkansanum</u>	x		x				x	

Table 7 contd.

	Lower marlstones			Algal lime-stones	Discocyclina limestones		Upper marlstones	
	1	2	3		7-9	10-11	13-16	17-20
<u>Cibicides blanpiedi</u>					x		x	
<u>C. compressa</u>					x	x	x	
<u>C. ekblomi</u>		x	x	x	x	x	x	
<u>C. howelli</u>				x	x	?	?	
<u>C. irenae</u>					x	x	x	x
<u>C. megaloperforatus</u>			x			x	x	
<u>C. neelyi</u>			x		?			
<u>C. succedens</u>		x	x	x	x	x	x	x
<u>Cibicidoides proprius</u>	x		x		x	x	x	
<u>Citharina plumoides</u>			x					
<u>Coleites reticulatus</u>					x			
<u>Dentalina colei</u>				x				
<u>D. crosswickensis</u>			x			x	x	
<u>D. gardnerae</u>						x		
<u>D. pseudoaculeata</u>	x						x	

Table 7 contd.

	Lower marlstones			Algal lime-stones	Discocyclina limestones		Upper marlstones	
	1	2	3	6	7-9	10-11	13-16	17-20
<u>Dentalina soluta</u>			x					x
<u>D. vertebralis</u>			x					
<u>Ellipsonodosaria cocoaensis</u>			x			x	x	x
<u>E. midwayensis</u>						x	x	
<u>E. plummerae</u>	x	x	x	x			x	x
<u>Epistominella minuta</u>	x							
<u>Eponides dorf1</u>			x		x	x	x	
<u>E. lunata</u>			x	x				
<u>E. plummerae</u>		x	x	x				
<u>E. toulmini</u>		x		x	x		x	x
<u>Fissurina sp.</u>						x		
<u>Frondicularia frankel</u>							x	
<u>F. goldfussi</u>							x	
<u>F. midwayensis</u>			x				x	
<u>F. naheolensis</u>							x	
<u>Globulina lacrima</u>		x	x	x	x		x	x

Table 7 contd.

	Lower marlstones			Algal lime-stones	Discocyclina limestones		Upper marlstones	
	1	2	3	6	7-9	10-11	13-16	17-20
<u>Guttulina communis</u>	x		x	x	x	x	x	x
<u>Gyroidina octocamerata</u>		x			x	x	x	
<u>G. subangulata</u>	x	x		x	x	x	x	x
<u>Karrerria fallax</u>			x	x				
<u>Lagena costata</u>						x		x
<u>L. sulcata semi-interrupta</u>				x	x	x	x	x
<u>Lamarckina rugulosa</u>							x	
<u>Loxostomum applinae</u>		x						
<u>Nodosaria affinis</u>							x	
<u>N. mcNeilli</u>	x		x	x		x		
<u>Nonionella sp.</u>	x					x	x	
<u>Oolina sp.</u>							x	
<u>Osangularia convexa</u>	x	x	x	x	x	x	x	x
<u>Planularia toddae</u>			x				x	
<u>Pseudouvigerina muralis</u>								x

Table 7 contd.

	Lower marlstones			Algal lime-stones	Discocyclina limestones		Upper marlstones	
	1	2	3	6	7-9	10-11	13-16	17-20
<u>Pseudouvierina seligi</u>	x	x	x	x		x	x	x
<u>P. triangularis</u>	x	x	x	x	x	x	x	x
<u>P. wilcoxensis</u>	x	x	x	x	x		x	
<u>Pullenia quinqueloba</u>			x				x	
<u>Quinqueloculina</u> sp.			x	x				x
<u>Ramulina globulifera</u>			x			x	x	x
<u>Rectoglandulina</u> sp.		x						
<u>Robulus alabamensis</u>			x					
<u>R. inornatus</u>				x	x	x	x	
<u>R. insulsus</u>			x					
<u>R. rosettus</u>							x	
<u>R. midwayensis</u>			x					
<u>R. turbinatus</u>			x			x	x	
<u>R. wilcoxensis</u>							x	
<u>Saracenaria triangularis</u>			x	x			x	

Table 7 contd.

	Lower marlstones			Algal lime-stones	Discocyclina limestones		Upper marlstones	
	1	2	3	6	7-9	10-11	13-16	17-20
<u>Siphogeneri-</u> <u>noides ele-</u> <u>ganta</u>			x					
<u>Tappanina</u> <u>selmensis</u>	x	x	x	x				x
<u>Vaginulina</u> <u>longiforma</u>					x	x	x	x
<u>Vaginulinopsis</u> <u>exquisita</u>			x	x				
<u>Virgulina</u> <u>wilcoxensis</u>	x					x		

Table 8

Vertical distribution of the Nerinea benthonic
foraminiferal species outside India.

Nerinea Benthonic species	Cretaceous	Paleocene of Egypt	Paleocene of Europe	Paleocene of North America	Eocene of Pak- istan (Laki)	Lower Eocene of Egypt	Lower Eocene of North America
<u>Aeolostreptis mary-</u> <u>landicus</u>				X			
<u>Alabamina midway-</u> <u>ensis</u>			X	X	X		X
<u>Allomorphina halli</u>			X	X			X
<u>Anomalinoides acuta</u>	X			X	X		X
<u>A. longi</u>							X
<u>A. umbonifera</u>		X		X		X	X
<u>Aragonia compressa</u>			X	X			
<u>Bolivina crenulata</u>				X			X
<u>Bulimina midway-</u> <u>ensis</u>		X	X	X			
<u>Bulimina ovata</u>							X
<u>B. referata</u>	X						
<u>B. virginiana</u>							X
<u>Chrysalogonium</u> <u>arkansanum</u>				X			

Table 8 contd.

	Cretaceous	Paleocene of Egypt	Paleocene of Europe	Paleocene of North America	Eocene of Pak- istan (Iaki)	Lower Eocene of Egypt	Lower Eocene of North America
<u>Cibicides blaniptedi</u>				X			X
<u>C. compressa</u>							X
<u>C. ekblomi</u>			X				
<u>C. howelli</u>				X			X
<u>C. irenae</u>							X
<u>C. megaloperforatus</u>		X					
<u>C. neelyi</u>				X			X
<u>C. succedens</u>			X	X			
<u>Cibicidoides proprius</u>			X				
<u>Citharina plumoides</u>			X	X			X
<u>Coleites reticulatus</u>			X	X	X		X
<u>Dentalina colei</u>				X			X
<u>D. crosswickensis</u>				X			
<u>D. gardnerae</u>				X			X
<u>D. pseudoaculeata</u>	X			X			X
<u>D. soluta</u>				X			X
<u>D. vertebralis</u>				X			X

Table 8 contd.

	Cretaceous	Paleocene of Egypt	Paleocene of Europe	Paleocene of North America	Eocene of Pak- istan (Laki)	Lower Eocene of Egypt	Lower Eocene of North America
<u>Ellipsonodosaria</u> <u>cocoaensis</u>							x
<u>E. midwayensis</u>				x			
<u>E. plummerae</u>				x			
<u>Epistominella minuta</u>				x			x
<u>Eponides dorfi</u>							x
<u>E. lunata</u>		x	x	x			
<u>E. plummerae</u>				x			
<u>E. toulmini</u>			x				x
<u>Frondicularia</u> <u>frankei</u>	x			x			
<u>F. goldfussi</u>		x		x			
<u>F. midwayensis</u>				x			
<u>F. naheolensis</u>				x			
<u>Globulina lacrima</u>	x		x	x			
<u>Guttulina communis</u>	x		x	x			
<u>Gyroidina octo-</u> <u>camerata</u>			x	x			x
<u>G. subangulata</u>		x		x			x

Table 8 contd.

	Cretaceous	Paleocene of Egypt	Paleocene of Europe	Paleocene of North America	Eocene of Pak- istan (Laki)	Eocene of Paris Basin	Lower Eocene of North America
<u>Karrereria fallax</u>	x						x
<u>Lagena costata</u>				x			x
<u>L. sulcata semi- interrupta</u>	x			x			
<u>Lamarckina rugulosa</u>	x			x			
<u>Loxostomum applinae</u>			x	x	x		
<u>Nodosaria affinis</u>	x	x		x	x		x
<u>N. mcNeilli</u>				x	x		
<u>Osangularia convexa</u>				x			x
<u>Planularia toddae</u>				x			
<u>Pseudouvigerina muralis</u>						x	
<u>P. seligi</u>	x						
<u>P. triangularis</u>				x			x
<u>P. wilcoxensis</u>			x	x			x
<u>Pullenia quinqueloba</u>	x		x	x	x		x
<u>Ramulina globulifera</u>	x		x	x			x
<u>Robulus alabamensis</u>				x			x
<u>R. inornatus</u>							x

Table 8 contd.

	Cretaceous	Paleocene of Egypt	Paleocene of Europe	Paleocene of North America	Eocene of Pak- istan (Laki)	Lower Eocene of Egypt	Lower Eocene of North America
<u>R. insulsus</u>				X			
<u>R. rosettus</u>				X			
<u>R. midwayensis</u>				X	X		X
<u>R. turbinatus</u>		X		X			X
<u>R. wilcoxensis</u>				X	X		X
<u>Saracenaria triangu- laris</u>	X	X					
<u>Siphogenerinoides eleganta</u>				X			
<u>Tappanina selmensis</u>	X		X	X			X
<u>Vaginulina longi- forma</u>				X			
<u>Vaginulinopsis exquisita</u>							X
<u>Virgulina wilcoxensis</u>							X

Table 9

Distribution of the Nerinea planktonic foraminiferal species in Pondicherry.

Zones	<u>Gr. trinidadensis</u>	<u>Gr. uncinata</u>	<u>Gr. whitei</u>	<u>Gr. velascoensis</u>	<u>Gr. rex</u>	<u>Gr. formosa formosa</u>	<u>Gr. pseudoscutula</u>
Species							
<u>Gr. trinidadensis</u>							
<u>Gg. daubjergensis</u>							
<u>Gr. compressa</u>							
<u>Chilogumbelina morsei</u>							
<u>C. midwayensis</u>							
<u>Gr. pseudobul- loides</u>							
<u>Gr. quadrata</u>							
<u>Gg. triloculinoides</u>							
<u>Gr. uncinata</u>							
<u>Gr. ehrenbergi</u>							
<u>Gr. pusilla pusilla</u>							
<u>Gr. aequa</u>							
<u>Gr. angulata</u>							
<u>Gr. whitei</u>							

Table 9 contd.

	<u>Gr. trinidadensis</u>	<u>Gr. uncinata</u>	<u>Gr. whitlei</u>	<u>Gr. velascoensis</u>	<u>Gr. rex</u>	<u>Gr. formosa formosa</u>	<u>Gr. pseudoscitula</u>
<u>Gr. pseudomenardii</u>							
<u>Gr. loeblichii</u>							
<u>Gg. spiralis</u>							
<u>Gg. mckannai</u>							
<u>Chilogobelia</u> <u>subtriangularis</u>							
<u>C. crinita</u>							
<u>Gr. abundocamerata</u>							
<u>Gg. velascoensis</u>							
<u>Gr. velascoensis</u>							
<u>Gr. convexa</u>							
<u>Gr. imitata</u>							
<u>Gr. pondicherriensis</u>							
<u>Gr. rex</u>							
<u>Gg. linaperta</u>							
<u>Gr. pseudoscitula</u>							
<u>Gr. formosa gracilis</u>							
<u>Gr. aragonensis</u>							

Table 9 contd.

	<u>Gr. trinidadensis</u>	<u>Gr. uncinata</u>	<u>Gr. whitei</u>	<u>Gr. velascoensis</u>	<u>Gr. rex</u>	<u>Gr. formosa formosa</u>	<u>Gr. pseudoscitula</u>
<u>Pseudohastigerina wilcoxensis</u>							
<u>Gg. triplex</u>							
<u>Gr. apanthema</u>							
<u>Gr. formosa formosa</u>							
<u>Gg. yeguensis</u>							
<u>Gr. broedermanni</u>							
<u>Gr. wilcoxensis</u>							
<u>Gr. nammalensis</u>							
<u>Gr. hispidicidaris</u>							
<u>Gg. turgida</u>							
<u>Gr. quetra</u>							
<u>G. cf densa</u>							

[illegible]

Table 10 contd.

[illegible]

Table 11

Algal species from the Algal limestones of the
Nerinea formation and their age distribution

Species	Age					
	L. Cretaceous	Paleocene	L. Eocene	M. Eocene	U. Eocene	L. Oligocene
<u>Archaeolithothamnium</u> <u>lugeoni</u> Pfender		X	X	X	X	X
<u>A. lakiensis</u> Varma		X				
<u>A. nammalensis</u> Varma		X				
<u>A. nummuliticum</u> (Gümbel)		X	X	X	X	X
<u>Lithothamnium</u> <u>abrardi</u> Lemoine		X	X	X		
<u>L. bofilli</u> Lemoine			X	X	X	
<u>Lithophyllum</u> <u>dubium</u> Lemoine		X	X	X		
<u>L. rajagopalani</u> n.sp.		New				
<u>Peyssonelia</u> <u>antiquitas</u> Johnson (a Squameraceae)		X				

Table 12

Relative abundance of Genera, Species and Individuals from Benthonic foraminiferal families in the Nerinea formation.

	Lower marlstones					
	PT 1			PT 2		
	Zone of <u>Gr. tri-</u> <u>nidadensis</u>			Zone of <u>Gr.</u> <u>uncinata</u>		
	FN 667			FN 1171		
	Gen.	Sp.	% indiv.	Gen.	Sp.	% indiv.
Lagenidae	3	5	2	3	3	2.5
Polymorphinidae	2	3	6	2	2	2.5
Buliminidae	5	6	50	3	4	5
Rotallidae	2	2	7	5	8	41
Ellipsoidinidae				1	3	4
Chilostomellidae & Nonionidae	1	1	-1	1	1	6
Uvigerinidae	1	2	5	1	3	8
Amomalinidae	2	8	32	2	7	31
Benthonics counted	208			200		
Planktonics	3.4%			43%		

Table 12 contd.

	Lower marlstones			Algal limestones		
	PT 3			PT 6		
	Zone of <u>Globorotalia whitei</u>					
	FN 4037 Gen. Sp. % indiv.			FN 1051 Gen. Sp. % indiv.		
Lagenidae	4	6	10	4	8	7
Polymorphinidae	3	3	8	2	2	13
Buliminidae	4	6	12	5	6	8
Rotaliidae	5	7	28	4	5	25.7
Ellipsoidinidae	1	4	5	1	1	1.6
Chilostomellidae & Nonionidae	2	2	10	2	2	17
Uvigerinidae	1	3	3	1	3	6
Anomalinidae	2	7	24	2	7	21.6
Benthonics counted	238			184		
Planktonics	10.2%			8.5%		

Table 12 contd.

	Discocyclina limestones					
	PT 7 Zone of <u>Gr.</u> <u>whitei</u>			PT 9 Zone of <u>Gr.</u> <u>velascoensis</u>		
	FN 265 Gen. Sp. %indiv.			FN 632 Gen. Sp. % indiv.		
Lagenidae	1	1	-1	2	2	1
Polymorphinidae	1	1	-1			
Buliminidae	1	1	1.5	2	3	2
Rotaliidae	4	7	15	4	5	6.5
Ellipsoidinidae	1	1	1.5			
Uvigerinidae	1	1	36.5	1	1	20
Anomalinidae	2	5	42.5	3	9	61
Miliolidae	1	1	1			
Silicininidae				1	1	-1
Discocyclinidae	present			1	1	12
Camerinidae				1	1	-1
Benthonics counted	200			208		
Planktonics	4.4%			3.5%		

Table 12 contd.

	Discocyclina limestones					
	PT 10			PT 11		
	Zone of <u>Globorotalia rex</u>					
	FN 383			FN 1190		
	Gen.	Sp.	%indiv.	Gen.	Sp.	%indiv.
Lagenidae	3	3	4	5	15	10
Polymorphinidae				4	5	2
Buliminidae	1	2	8.3	4	6	17
Rotaliidae	4	5	15.8	3	5	5
Ellipsoidinidae				1	1	1
Uvigerinidae	2	2	7.5	1	4	9
Anomalinidae	2	11	51.2	2	12	44
Miliolidae				1	1	1
Discocyclinidae	1	1	12.5	1	1	12
Benthonics counted		120			410	
Planktonics		13%			12.3%	

Table 12 contd.

	Upper marlstones					
	PT 13			PT 14		
	Zone of <u>Globorotalia formosa</u>					
	<u>formosa</u>					
	FN 3632			FN 1914		
	Gen. Sp. %indiv.			Gen. Sp. % indiv.		
Lagenidae	8	17	9.4	4	5	11
Polymorphinidae	2	2	1.1			
Buliminidae	2	5	18	3	5	7
Rotaliidae	4	7	18.4	2	4	2.6
Ellipsoidinidae				1	1	1.3
Chilostomellidae & Nonionidae	3	3	1	2	2	2.3
Uvigerinidae	1	3	2.6	1	2	6.6
Anomalinidae	3	13	43	3	13	67
Miliolidae	1	1	-1			
Discocyclinidae	1	1	7	1	1	2
Benthonics counted			352			307
Planktonics			19%			15%

Table 12 contd.

	Upper marlstones					
	PT 15			PT 16		
	Zone of <u>Globorotalia formosa</u>					
	<u>formosa</u>					
	FN 1952			FN 2076		
	Gen.	Sp.	% indiv.	Gen.	Sp.	% indiv.
Lagenidae	7	7	8.5	7	16	14.3
Polymorphinidae	2	2	4	1	1	1.6
Buliminidae	2	4	15	3	4	29.3
Rotaliidae	3	4	7.5	3	4	12.6
Ellipsoidinidae	1	2	-1	1	1	1.6
Chilostomellidae & Nonionidae	1	1	-1	1	1	-1
Uvigerinidae	1	2	25	1	2	8.6
Anomalinidae	2	11	37	2	13	33.9
Miliolidae				1	1	-1
Discocyclinidae	1	1	2.5	1	1	1.3
Benthonics counted			310			303
Planktonics			24%			42.8%

Table 12 contd.

	Upper marlstones					
	PT 20			PT 17		
	Zone of <u>Globorotalia pseudoscitula</u>					
	FN 716			FN 607		
	Gen.	Sp.	% indiv.	Gen.	Sp.	% indiv.
Lagenidae	3	3	2.4	5	5	9
Polymorphinidae	1	1	3.2	1	4	2
Buliminidae	2	2	1.2	2	4	3
Rotalidae	3	3	2	3	5	26
Ellipsoidinidae	1	1	-1			
Chilostomellidae & Nonionidae						
Uvigerinidae	1	3	34	1	1	30
Anomalinidae	2	7	56	2	8	30
Miliolidae				1	1	-1
Discocyclinidae	1	1	1.2			
Benthonics counted			252			303
Planktonics			31.4%			36.5%

Table 12 contd.

	Upper marlstones					
	PT 18			PT 19		
	Zone of <u>Globorotalia pseudoscitula</u>					
	FN 2154			FN 316		
	Gen.	Sp.	% indiv.	Gen.	Sp.	% indiv.
Lagenidae	3	3	2			
Polymorphinidae	1	1	-1			
Buliminidae	3	4	41.8	4	5	18.6
Rotaliidae	4	7	8.2			
Ellipsoidinidae	1	2	8			
Chilostomellidae & Nonionidae	1	1	2			
Uvigerinidae	2	2	7	1	2	6
Anomalinidae	2	7	31	2	3	76
Benthonics counted			306			316
Planktonics			33%			55.6%

Classification of the Upper Cretaceous and Lower Tertiary rocks of
Pondicherry - India.

Age	European stages	Lithological units	Planktonic foraminiferal zones
Early Tertiary	Ypresian	Upper marlstone	<u>Globorotalia pseudoscutula</u>
	2		<u>Globorotalia formosa formosa</u>
	Sparnacian	<u>Discoeyclina</u> limestone	<u>Globorotalia rex</u>
	2		<u>Globorotalia velascoensis</u>
	Landenian	Algal limestone	<u>Globorotalia whitei</u>
Late Cretaceous	Danian	Lower marlstone	<u>Globorotalia uncinata</u>
			<u>Globorotalia trinidadensis</u>
	Maestrichtian	Trigonarca formation	<u>Globotruncana gansseri</u>
	Late Campanian	Valudavur formation	<u>Globotruncana lapparenti</u> <u>tricarinata</u>

TABLE 13

Fig.2

Generalized columnar section of the Valudavur and
Trigonarca formations

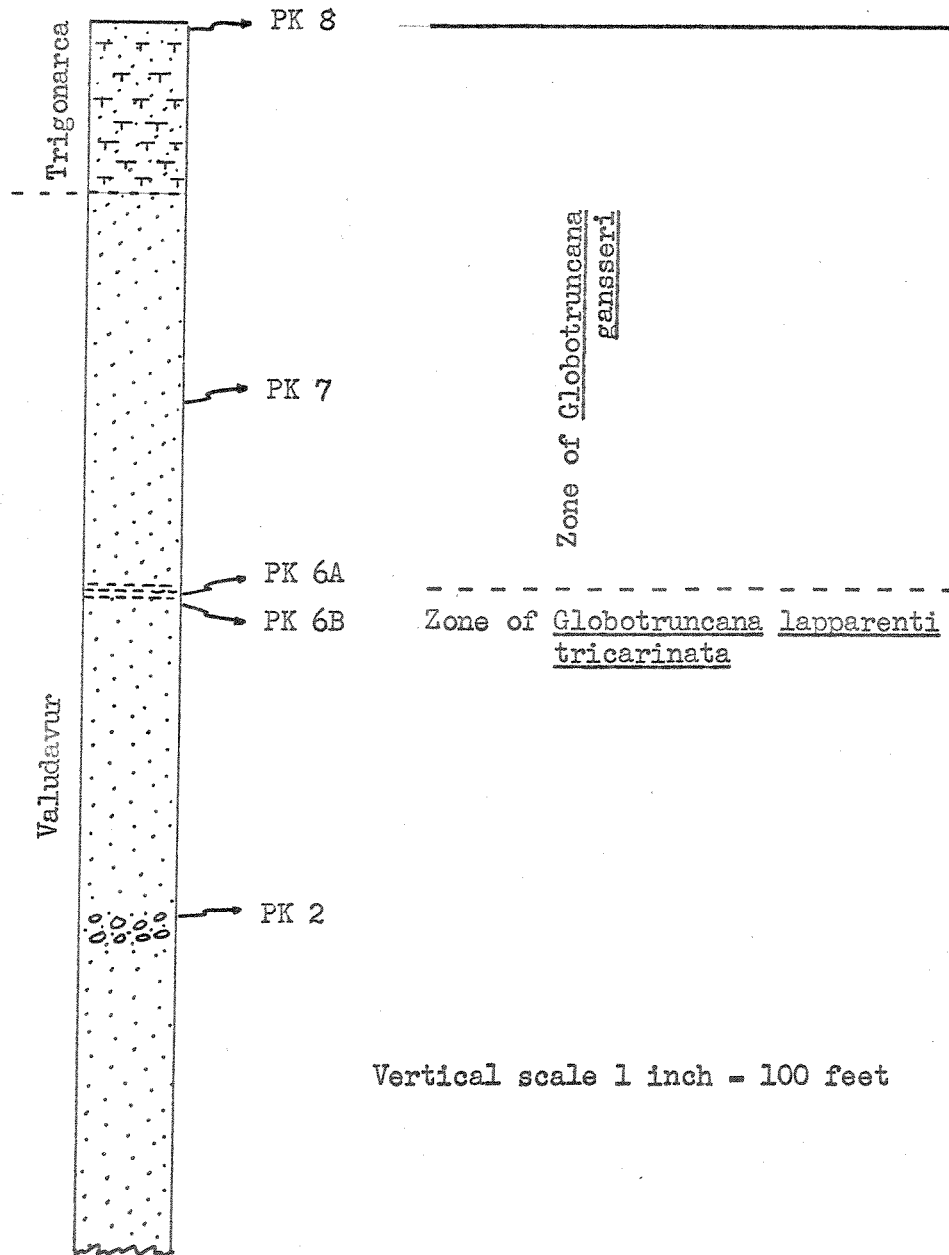
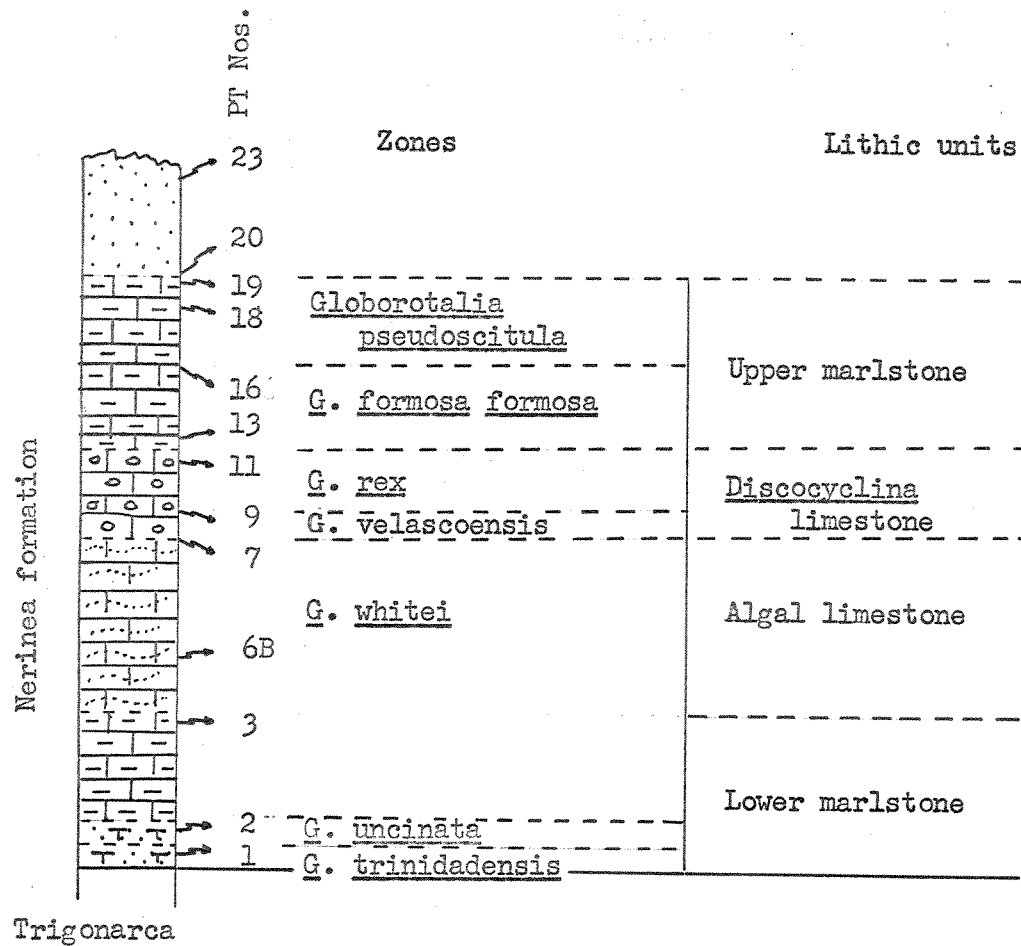


Fig.3

Generalized columnar section of the
Nerinea formation



Vertical scale 1 inch = 50 feet

SYSTEMATIC DESCRIPTIONS
PLANKTONIC FORAMINIFERA

Family HETEROHELICIDAE

Genus Heterohelix Ehrenberg, 1841

Heterohelix carinata (Cushman)

pl.1, fig. 8

Gumbelina carinata Cushman, 1938, p. 18, pl. 3, fig. 10

Heterohelix carinata (Cushman), Montanaro Gallitelli,
1957, p.137, pl.31, fig.16.

Remarks: This species is identified by its compressed test with chambers more broad than high and the distinct carina.

Length .22 mm. Greatest width .15 mm.

Occurrence: This species has been recorded from the U.S.Gulf Coast (Austin and Taylor). In Pondicherry it occurs very rarely at PK 6 (10 feet).

Types: Figured hypotype R 5200

Heterohelix globulosa (Ehrenberg)

pl.1, fig. 9

Textilaria globulosa Ehrenberg, 1834, p.135, pl.4, fig.
4B.

Gumbelina globulosa (Ehrenberg), Cushman, 1946, p.105,
pl.45, figs.9-15; Said and Kenawy, 1956, p.139,
pl.3, fig.29.

Heterohelix globulosa (Ehrenberg), Gallitelli, 1957,
p.137, pl.31, figs.12-15. Takayanagi, 1960,
p.119, pl.VII, fig.20.

Remarks: This species is identified by its smooth globular chambers.

Length 0.20 mm. Greatest width 0.13 mm.

Occurrence: This species has been widely recorded from the Upper Cretaceous strata: U.S.Gulf Coast (Taylor and Navarro), Canada, Germany, Paris Basin, Egypt, Japan, and Australia. In the Khasi hills of Assam it has been recorded from strata assigned to Danian age. In Pondicherry it is found rarely at PK 6.

Figured hypotype R 5201

Heterohelix planata (Cushman)

pl. 1, fig. 10

Gumbelina planata Cushman, 1938, p.12, pl.2, figs.13,14.

Heterohelix planata (Cushman), Gallitelli, 1957, p.137.

Remarks: This species is identified by its compressed test, slight peripheral keel and smooth surface. The early stage is distinctly coiled.

Length 0.25 mm. Greatest width 0.16 mm.

Occurrence: Cushman has recorded this species from the Campanian of U.S.Gulf Coast (Taylor marl). It is rarely found in sample A at locality PK 6.

Types: Figured hypotype USNM 641352 R 5202

Heterohelix pulchra (Brotzen)

pl.1, fig. 6

Gümbelina pulchra Brotzen, 1936, p.121, pl.IX, figs.2,3.

Heterohelix pulchra Gallitelli, 1957, p.137, pl.31, fig.20

Gümbelina tessera Cushman, 1932, p.338, pl.51, figs.4,5.

Jennings, 1936, p.27, pl.3, fig.10.

Gümbelina pseudotessera Cushman, 1938, p.14, pl.2, figs.

19-21.

Remarks: This species is identified by its small compressed test with broad chambers and the aperture with lateral flanges.

Length 0.20 mm. Greatest width 0.15 mm.

Occurrence: This species has been recorded from the Upper Cretaceous of U.S.Gulf Coast, New Jersey and Trinidad. It is found rarely in the Valudavur formation at PK 7.

Figured hypotype R 5203

Heterohelix striata (Ehrenberg)

pl.1, fig. 11

Textularia striata Ehrenberg, 1840, p.135, pl.4, figs.1a,

1a¹, 2a, 3a, 9a.

Gümbelina striata (Ehrenberg), Cushman, 1946, p.104, pl.

45, fig.4,5.

Heterohelix striata (Ehrenberg), Berggren, 1962, p.21,
pl.VI, figs. 1a - 5b.

Remarks: The surface striations are diagnostic of this species. This species differs from Heterohelix navarroensis Loeblich (1951) in its much larger size.

Length 0.30 mm Greatest width 0.20 mm.

Occurrence: This species is found commonly in the Maestrichtian of the North American Gulf Coast, of northwestern Europe and in abundance in the uppermost Maestrichtian of Scandinavia. It occurs in abundance in the Valudavur formation at PK 6 and 7. It occurs rarely in the Trigonarca formation.

Types: USNM 641353 R 5204

Heterohelix sp.

pl.1, fig.7

This species is recognized by the rapidly tapering compressed test with carinate early portion of the periphery, depressed somewhat curved sutures, and faintly ribbed or striated surface. Details of aperture not clear. This species is distinguished from H. pulchra in the carinate periphery and ribbed surface.

Length 0.32 mm. Greatest width 0.30 mm.

Occurrence: A few specimens are found in the Valuda-

vur formation at PK 6 (sample A) and PK 7.

Figured specimen R 5205

Genus Pseudoguembelina Bronniman and Brown, 1953

Pseudoguembelina excolata (Cushman)

Bronnimann and Brown

pl.1, fig. 20

Guembelina excolata Cushman, 1926, p.20, pl.2, fig.9.

Le Roy, 1953, p.34, pl.7, figs.24,25; Hamilton,
1953, p.234, pl.30, fig.11.

Pseudoguembelina excolata (Cushman), Bronnimann and

Brown, 1953, text-figs. 1-4; Said and Kenawy,
1956, p.139, pl.3, fig.36.

Pseudoguembelina costulata (Cushman), Pessagno, 1962,

p.358, pl.1, fig.6.

Remarks: This species is characterised by its biserial tapering test, surface ornamentation by relatively strong costae and the presence of accessory apertures. Owing to the poor preservation of the present material the accessory apertures are not clearly seen.

Length 0.38 mm. Greatest width 0.21 mm.

Occurrence: This species has been recorded from the Upper Cretaceous of Mexico, Puerto Rico, U.S.Gulf Coast, New Jersey, Columbia, Cuba, Egypt, Israel, Mid-Pacific sea mounts and of Trinidad. In the Valudavur formation

it is distributed sparsely at all fossiliferous localities.

Types: Figured hypotype R 5206

Genus Guembelitria Cushman, 1933

Guembelitria cretacea Cushman

pl.1, fig. 16

Guembelitria cretacea Cushman, 1933, p.34, pl.4, fig.12.

Gallitelli, 1957, p.136, pl.31, fig.1.

Remarks: This species is identified by its triserial test with globular chambers arranged in three regular series.

Length 0.13 mm. Greatest width 0.06 mm.

Occurrence: This species occurs in abundance in the Valudavur formation at localities PK 6 (sample A) and PK 7. Elsewhere it has been recorded in the Upper Cretaceous of North America (Mt. Laurel and Navesink formations).

Types: Figured hypotype R 5207

Genus Pseudotextularia Rzehak, 1891

Pseudotextularia elegans (Rzehak), Gallitelli

pl.1, fig. 17

Cuneolina elegans Rzehak, (part), 1891, p.2.

Guembelina elegans White, 1929, p.34, pl.4, fig.8.

Pseudotextularia elegans Gallitelli, 1957, p.138, pl.33,
fig. 6.

Guembelina plummerae Loetterle, 1937, p.33, pl.5, figs.

1,2. Said and Kenawy, 1956, p.139, pl.3, fig.33.

Nagappa, 1959, pl.7, figs.5,6 (not 7,8)

Remarks: Characteristic features of this species are the compressed, tapering, biserial test rapidly increasing in thickness, longitudinal costae and a low broad arched aperture.

Length 0.43 mm. Maximum width 0.30 mm.

Maximum thickness 0.30 mm.

Occurrence: This species is worldwide in distribution in strata of Maestrichtian age. It has been recorded from the North American Gulf Coast, Atlantic Coastal Plain, Denmark and Egypt. In India it occurs in the Maestrichtian of Assam (Mahadek stage). It is of common occurrence in the Valudavur formation; rare in Trigonarca.

Types: Figured hypotype USNM 641354 R 5208

Pseudotextularia fructicosa (Egger)

pl.1, fig. 5

Guembelina fructicosa Egger, 1900, p.35, pl.14, figs.8,9.

Racemiguembelina fructicosa (Egger), Gallitelli, 1957,

p.142, pl.32, figs.14,15.

Pseudotextularia varians Rzehak, Cushman, 1946, p.110,
pl.47, figs.4-9.

Pseudotextularia elegans (Rzehak), Nagappa, 1959, pl.7,
fig.7,8.

Remarks: This species is characterised by the chamber proliferation in the adult; otherwise it is similar to Pseudotextularia elegans.

Length 0.42 mm. Maximum width 0.35 mm.

Maximum thickness 0.36 mm.

Occurrence: The type species is from the Senonian of Bavarian Alps, Germany. In northwestern Europe, it occurs only in the Uppermost Maestrichtian, whereas in the U.S. Gulf Coast, Trinidad, Caucasus, and Middle East it also occurs in the Lower Maestrichtian. In India this species has been recorded from the Maestrichtian of Assam (Mahadek stage). In the Valudavur formation of Pondicherry it occurs commonly at PK 6 (sample A) and PK 7. It very rarely occurs in the Trigonarca formation.

Types: Figured hypotype USNM 641355 R 5209

Genus Chiloguembelina Loeblich and Tappan, 1956

Chiloguembelina crinita (Glaessner)

Guembelina crinita Glaessner, 1937, p.383, pl.4, fig.34.
Chiloguembelina crinita (Glaessner), Loeblich and Tappan,
 1957, p.89, pl.21, fig.4, text-fig.14 (1-4);
 Pl.49, fig.1; pl.51, figs.1a-3; pl.56, figs.1a,b;
 pl.60, fig.6; pl.62, fig.1. Olsson, 1960, p.29,
 pl.4, figs.14,15.

Remarks: This species is identified by the small, compressed rapidly tapering test, the large ovate final chamber and the semicircular aperture.

Length 0.27 mm. Greatest width 0.18 mm.

Occurrence: Glaessner described this species from the Paleocene or Lower Eocene of Caucasus. It is of widespread occurrence in the North American Gulf and Atlantic Coastal Plains. It is sparsely distributed in the Upper marlstones of the Nerinea formation at localities PT 13 to PT 17.

Types: R 5210

Chiloguembelina midwayensis (Cushman)

Guembelina midwayensis Cushman, 1940, p.65, pl.11, fig.15.
Chiloguembelina midwayensis (Cushman), Loeblich and Tappan, 1957, p.179, pl.43, fig.7; pl.45, fig.9;
 pl.41, fig.3; Olsson, 1960, pl.4, fig.16,17.

Remarks: This species is identified by the small, elongate, rapidly tapering test, depressed sutures and the broad open arched aperture at the base of the final chamber. The test is less flaring than that of Chiloguembelina crinita.

Length 0.26 mm. Maximum width 0.15 mm.

Occurrence: This species has been recorded from the Paleocene of North American Gulf and Atlantic Coastal Plains. In Pondicherry it is present in the Lower marlstones of the Nerinea formation at all localities.

Types: R 5211

Chiloguembelina morsei (Kleine)

Guembelina morsei Kline, 1943, p.44, pl.7, fig.12.

Chiloguembelina morsei (Kline), Loeblich and Tappan, 1957, p.179, pl.40, fig.2; pl.41, fig.4; pl.42, fig.1; pl.43, figs.2,6.

Remarks: This species is characterised by a small narrow elongate test with 5 to 7 pairs of subglobular chambers and deeply constricted sutures.

Length 0.24 mm. Maximum width 0.13 mm.

Occurrence: This species has been recorded from the Danian strata of Denmark and the U.S.Gulf Coast. In Pondicherry it occurs restricted to the lower beds of

of the Lower marlstones of the Nerinea formation at localities PT 1 and PT 2.

Types: R 5212

Chiloguembelina subtriangularis Beckmann

Chiloguembelina subtriangularis Beckmann, 1957, p.91,
pl.21, fig.5, text-fig. 15 (39-42)

Remarks: This species is characterised by the small subtriangular compressed test with a subangular periphery and slightly depressed horizontal sutures.

Length 0.18 mm. Maximum width 0.13 mm.

Occurrence: Beckmann described this species from the Lower Lizard Springs formation (Paleocene) of Trinidad. It occurs sparsely in the Nerinea formation at all localities.

Types: R 5213

Family ROTALIPORIDAE Sigal, 1958

Genus Praeglobotruncana Bermudez, 1952

Praeglobotruncana petaloidea (Gandolfi)

pl.1, fig. 12,13.

Globotruncana (Rugoglobigerina) petaloidea petaloidea

Gandolfi, 1955, p.52, pl.3, fig.13 a-c.

Rugoglobigerina jerseyensis Olsson, 1960, p.49, pl.10,

figs.19-21.

Praeglobotruncana (Hedbergella) petaloidea (Gandolfi),

Berggren, 1962, p.41, pl.VII, figs.4 a-c.

Remarks: This species is characterised by a low trochospiral compressed test with a slightly concave umbilical side, strongly lobulate peripheral margin without keel, and a densely spinose surface. In the present material there is a slight variation in the convexity of the spiral side.

Greatest diameter 0.36 Thickness 0.18 mm.

Occurrence: This species has been recorded from the Maestrichtian of Denmark, Scandinavia and U.S. Gulf and Atlantic Coastal Plains. It is present in the Valudavur formation at PK 6 (sample A) and PK 7.

Types: Figured hypotype USNM 641356 R 5214

Family PLANOMALINIDAE Bolli, Loeblich and Tappan,

1957

Genus Planomalina Loeblich and Tappan, 1946

Planomalina messinae (Bronnimann)

pl.2, fig. 12

Globigerinella messinae messinae Bronnimann, 1952, p.42,

pl.1, figs.6,7; text-fig. 20 a-q.

Biglobigerinella biforaminata (Hofker), Olsson, 1960,

p.44, pl.8, figs. 7,8.

Planomalina (Globigerinelloides) messinae (Bronniman),
Berggren, 1962, p.44, pl.VIII, figs.4-8, text-
figs. 6,7.

Remarks: This species is identified by the small planispiral biumbilicate test with inflated globular chambers, open umbilicus and the equatorial aperture with lip like projection. In the present material one specimen shows a tendency to develop a bipartite aperture.

Diameter 0.19 mm.

Occurrence: This species has been recorded from the Maestrichtian of Scandinavia, Trinidad and the U.S. Atlantic Coastal Plain. It is found very rarely in the Valudavur formation at localities PK 6 (sample A) and PK 7.

Types: Figured hypotype R 5215

Family GLOBOTRUNCANIDAE Brotzen, 1942

Genus Globotruncana Cushman, 1927

Globotruncana arca (Cushman)

pl.2, figs. 6,7

Pulvinulina arca Cushman, 1926, p.23, pl.3, fig. 1.

Globotruncana arca (Cushman), Bolli, Loeblich and Tappan,
1957, p.44, pl.11, figs. 6-11 c.

Remarks: The diagnostic characters of this species are its large size, moderately arched spiral side, limbate spiral sutures and two prominent beaded well separated keels.

Greatest diameter 0.54 mm. Thickness 0.27 mm.

Occurrence: This species is widely distributed in strata of Maestrichtian age. It has been reported from Denmark, Tunisia, Trinidad, U.S. Gulf Coast etc. Typical specimens of this species are found in the Valudavur formation at PK 6 (Sample A) and PK 7 localities.

Types: Figured hypotype USNM 641357 R 5216

Globotruncana contusa (Cushman)

pl.2, figs. 10,11

Pulvinulina arca var. contusa Cushman, 1926, p.23

Globotruncana arca var. contusa (Cushman), Cushman, 1946, p.150, pl.62, figs.6 a,b.

Globotruncana contusa (Cushman), Bolli, 1951, p.196, pl. 34, figs. 7-9.

Globotruncana contusa (Cushman), Troelsen, 1955, p.80, text-fig. 2.

Remarks: The identifying characters of this species are the strongly elevated spiral side, undulating wall surface, beaded spiral sutures and concave umbilical side.

Greatest diameter 0.31 mm. Thickness 0.25 mm.

Occurrence: This species has been recorded from the Maestrichtian of Denmark, Italy, Trinidad, Mexico, U.S. Atlantic Coastal Plain, northwestern Australia, and the Upper Campanian and Maestrichtian of northern Caucasus etc. A few typical specimens of this species are found in the Valudavur formation at locality PK 6 (sample A).

Types: Figured hypotype USNM 641358 R 5217

Globotruncana fornicata Plummer

pl.1, figs. 18,19.

Globotruncana fornicata Plummer, 1931, p.198, pl.43, figs.4a-c,5,6; Cushman, 1946, p.149, pl.61, fig. 19; Bronnimann and Brown, 1955, p.542, pl.XXI, figs. 7,14,15.

Remarks: This species is identified by the long, narrow, curved and elongated chambers.

Diameter 0.35 mm. Thickness 0.18 mm.

Occurrence: This species has a wide distribution in Campanian and Lower Maestrichtian strata. It has been recorded from the North American Gulf Coast, New Jersey, Trinidad, Tunisia etc. A few specimens of this species are found in the Valudavur formation at locality PK 6 (sample B).

Types: Figured hypotype R 5218

Globotruncana gagnebini Tilev

pl.2, figs. 8,9

Globotruncana gagnebini Tilev, 1952, p.50, pl.3, figs.

2-5, text-figs. 14a-17d. Bolli, 1957, p.59, pl.

14, fig.5.

Remarks: The identifying characters of this species are the flat spiral side, strongly convex umbilical side, two closely set keels and the deep wide umbilicus.

Diameter 0.36 mm. Thickness 0.23 mm.

Occurrence: Bolli has recorded this species from the Maestrichtian of Trinidad. It is present in the Valudavur formation at localities PK 6 (sample A) and PK 7.

Types: Figured hypotype R 5219

Globotruncana gansseri Bolli

pl.2, figs. 4,5

Globotruncana gansseri Bolli, 1951, p.196, pl.35, fig.1-3.

Rugotruncana gansseri (Bolli), Bronnimann and Brown, 1956,

p.548, pl.23, figs.7-9.

Globotruncana monmouthensis Olsson, 1960, p.50, pl.10,

figs. 22-24.

Globotruncana (Rugotruncana) gansseri (Bolli), Pessagno,

1960, p.102, pl.4, fig.11.

Remarks: This species is identified by its plano-convex test, inflated chambers on the ventral side, single keel and spinose surface.

Diameter 0.33 mm. Thickness 0.18 mm.

Occurrence: This species has been recorded from the Lower Maestrichtian of Trinidad and Upper Maestrichtian of Denmark. It is present in the Valudavur formation at locality PK 6 (sample A).

Types: Figured hypotype USNM 641359 R 5220

Globotruncana linneiana (d'Orbigny)

Rosalina linneiana d'Orbigny, 1839, p.101, pl.5, figs. 10-12.

Globotruncana linneiana (d'Orbigny), Bronnimann and Brown, 1955, p.540, pl.XX, figs.13-17; pl.XXI, figs.16-18.

Remarks: The diagnostic characters of this species are the flat spiral and umbilical sides of the test and two distinct well separated keels.

Diameter 0.21 mm Thickness 0.13 mm.

Occurrence: This species has been recorded from the Upper Cretaceous (Turonian - Campanian) of Cuba. It occurs very rarely in the Valudavur formation at locality PK 6 (sample B).

Types: R 5221

Globotruncana marginata (Reuss)

Rosalina marginata Reuss, 1845, p.36, pl.8, figs.54,74;
pl.13, fig. 68.

Globotruncana marginata (Reuss), Cushman, 1946, p.150,
pl.62, figs. 1,2.

Remarks: This species is characterised by its inflated chambers 4 or 5 in number, truncated periphery, and two faint keels one forming the dorsal margin and the other forming the ventral margin.

Greatest diameter 0.31 mm. Thickness 0.20 mm.

Occurrence: This species has been recorded from the Upper Cretaceous of the North American Gulf Coast. It is present in the Valudavur formation at locality PK 6 (sample A).

Types: R 5222

Globotruncana mariei Banner and Blow

Globotruncana cretacea Cushman, 1938, p.67, pl.11, fig.6;
Cushman, 1946, p.151, pl.62, fig.7; Bronnimann
and Brown, 1956, p.546.

Globotruncana mariei Banner and Blow, 1960, p.8

(new name for Globotruncana cretacea Cushman, 1938, which is a junior homonym of Globigerina cretacea d'Orbigny, 1840 = Globotruncana cretacea (d'Orbigny).

Berggren, 1962, p.55, pl.IX, fig.5.

Remarks: This species is characterised by its low biconvex test, finely beaded spiral sutures and close-set double keel. Globotruncana rosetta (Carsey), to which this species bears resemblance, has a single keel in the adult stage. This species also resembles Globotruncana arca, from which it is distinguished by lesser number of chambers in the final whorl and less pronounced convexity of the spiral side.

Diameter 0.46 mm. Thickness 0.25 mm.

Occurrence: This species has been recorded from the Uppermost Maestrichtian of Scandinavia and from the Campanian - Maestrichtian of North American Gulf Coast. It is present in the Valudavur formation at localities PK 6 (sample A) and PK 7.

Types: R 5223

Globotruncana stuarti stuartiformis Dalbiez

pl.2, figs. 1,2,3

Globotruncana (Globotruncana) elevata stuartiformis

Dalbiez, 1955

Globotruncana stuarti stuarti (de Lapparant), Gandolfi,
1955, p.64, pl.5, fig.6.

Globotruncana (Globotruncana) stuarti stuartiformis

Dalbiez, Pessagno, 1960, p.101, pl.5, figs.7,11.

Pessagno, 1962, p.362, pl.2, figs. 4-6.

Remarks: This species is characterised by its gently convex spiral side and strongly convex umbilical side, limbate spiral sutures disposed in a subtriangular manner and its single keel. Globotruncana stuarti stuarti (de Lapparant) has a more convex umbilical side and its spiral sutures are trapezoidal.

Diameter 0.58 mm. Thickness 0.33 mm.

Occurrence: This species has been recorded from the Campanian and Lower Maestrichtian of Tunisia, Columbia (South America), and the Maestrichtian of Puerto Rico and the U.S. Atlantic Coastal Plain.

Types: Figured hypotype USNM 641360 R 5224

Globotruncana subcircumnodifer (Gandolfi)

Globotruncana (Rugoglobigerina) circumnodifer subcircumnodifer Gandolfi, 1955, p.44, pl.2, fig.8.

Globotruncana (Rugotruncana) subcircumnodifer (Gandolfi)

Berggren, 1962, p.67, pl.X, fig.4.

Remarks: The identifying characters of this species are the moderately biconvex test, subcircular peripheral outline, two keels, 5-7 compressed or subglobular later chambers and the rugose surface.

Diameter (greatest) 0.25 mm. (shortest) 0.18 mm.

Thickness 0.13 mm.

Occurrence: Gandolfi described this species from Columbia. It has been recorded from the Maestrichtian of Denmark, U.S. Gulf and Atlantic Coastal Plains. It is well represented in the Valudavur formation at locality PK 7.

Types: R 5225

Globotruncana cf G. tricarinata (Quereau)

Remarks: The present material is not typical of Globotruncana tricarinata. It represents a stage in the development of G.tricarinata to G.arca.

Diameter 0.41 mm. Thickness 0.20 mm.

Occurrence: Globotruncana tricarinata is widely distributed in the Upper Campanian and Lower Maestrichtian strata. The present form is found in the Valudavur formation at PK 6 and PK 7 localities.

Types: R 5226

Genus Rugoglobigerina Bronnimann, 1952

Rugoglobigerina pustulata Bronnimann

pl.1, figs. 14,15

Rugoglobigerina reicheli pustulata Bronnimann, 1952,

p.20, pl.2, figs. 7-9, text-figs.6,7. Olsson,

1960, p.50, pl.10, figs.13-15.

Rugoglobigerina reicheli hexacamerata, Bronnimann, 1952,

p.23, pl.2, figs.10-12, text-fig.8.

Rugoglobigerina pustulata Bronnimann, Berggren, 1962,

p.78, pl.XIII, fig.1, text-fig.10 (6-12)

Remarks: This species is characterised by a small, low trochospiral test, slightly depressed spiral side, 5-6 subglobular chambers in the final whorl with rugose surface.

Diameter 0.20 mm.

Occurrence: This species has been recorded from the Maestrichtian of Denmark and the U.S. Atlantic Coastal Plain. It is restricted to the top most Maestrichtian of Trinidad. It is present in the Valudavur formation at locality PK 7.

Types: Figured hypotype R 5227

Rugoglobigerina rotundata Bronnimann

pl.1, figs. 1,2

Rugoglobigerina rugosa rotundata Bronnimann, 1952, p.34

pl.4, figs.7-9, text-figs.15-16.

Kuglerina rotundata Bronnimann and Brown, 1956, p.557

Remarks: There is only one specimen available in the present material which is questionably assigned to this species. While it has all the characteristics diagnostic of the species, the umbilicus is somewhat larger.

Diameter 0.35 mm Thickness 0.26 mm.

Occurrence: This species has been recorded from the Maestrichtian of Trinidad. The present specimen is from the Valudavur formation, locality PK 7.

Type: Figured hypotype 5228

Rugoglobigerina rugosa (Plummer)

pl.1, figs.3,4

Globigerina rugosa Plummer, 1926, p.39, pl.2, fig.10.

Rugoglobigerina rugosa rugosa (Plummer), Bronnimann, 1952, p.28, text-figs,11-13; Olsson, 1960, p.50, pl.10, figs.16-18.

Rugoglobigerina rugosa (Plummer), Bolli, Loeblich and Tappan, 1957, p.42, pl.11, fig.2; Berggren, 1962 p.71, pl.XI, figs.1-5, text-fig. 8.

Remarks: Strong meridional rugosities characteristic of this species are only faintly developed in the present material. Otherwise it compares well with the types.

Diameter 0.36 mm.

Occurrence: This species has been recorded from the Maestrichtian of Denmark, U.S. Gulf and Atlantic Coastal Plains. In Trinidad it is found in strata ranging in age from Turonian to Maestrichtian. This species occurs abundantly in the Valudavur formation at PK 6 and PK 7 localities.

Types: Figured hypotype USNM 641361 R 5229

Family ORBULINIDAE

Genus Globigerina d'Orbigny, 1826

Globigerina daubjergensis Bronnimann

pl.3, fig. 19

Globigerina daubjergensis Bronnimann, 1953, p.340, text-

fig.1; Boll, 1957, p.70, pl.16, figs.13-15;

Troelsen, 1957, p.128, pl.30, figs. 1,2; Berggren,

1962, p.80, pl.XIII, figs.3-7, text-fig. 11.

Globigerinoides daubjergensis (Bronnimann), Loeblich and

Tappan, 1957, p.184, pl.40, fig.1,8; pl.41, fig.9;

pl.42, figs.6,7; pl.43, fig.1, pl.44, figs.7,8.

Olsson, 1960, p.43, pl.8, figs.4-6.

Remarks: This species is characterised by its small sized high trochospiral test with globular chambers that increase rapidly in size, a finely spinose surface and umbilical aperture. Supplementary sutural apertures noted

noted by authors are not seen in the present material.

Greatest diameter 0.16mm.

Occurrence: This species is a guide fossil for the Danian. It has been recorded from the Danian strata in several parts of the world viz: Sweden, Trinidad, Denmark, N.Italy, U.S. Gulf and Atlantic Coastal Plains.

Typical specimens of this species are present in the basal beds of the Lower marlstones of the Nerinea formation at locality PT 1.

Types: Figured hypotype USNM 641362 R 5230

Globigerina linaperta Finlay

Globigerina linaperta Finlay, 1939, p.125, pl.13, figs.

54-57; Bolln, 1957, p.163, pl.36, fig.5; Hornibrook, 1958, p.33, pl.1, figs.19-21.

Globigerina triloculinoides Plummer, Loeblich and Tappan,

1957 (part) (not Plummer 1926).pp.183-184, pl.62, figs.3,4; pl.52, figs.3,4,5; pl.56, fig.8.

Globigerina linaperta linaperta Finlay, Eames, Banner,

Blow and Clarke, 1962, pp.85-87, pl.XI, fig.H.

Remarks: There has been much confusion as regards the identity of this species. Eames, Banner, Blow and Clarke (1962) have given a critical discussion of this form.

The identifying characters of this species are the three slightly flattened chambers of the last whorl, very small, scarcely visible umbilicus and the long, low arched aperture symmetrically extending across the umbilicus and provided with a lip.

Long diameter 0.33 mm. Short diameter 0.28 mm.

Occurrence: This species has been recorded from several Middle Eocene strata. In East Africa it is known to occur associated with a planktonic foraminiferal fauna of Late Paleocene age and range upto the latest Eocene. In Trinidad it occurs in the Lizard Springs formation (Globorotalia ehrenbergi zone to Globorotalia aragonensis zone) continuing into the Navet formation. It occurs in the Upper Paleocene and Eocene formations of N.America.

This species is of common occurrence in the Discocyclina limestone and the Upper marlstones of the Nerinea formation at all localities.

Types: R 5231

Globigerina mckannai White

Globigerina mckannai White, 1928, p.194, pl.27, fig. 16.

Loeblich and Tappan, 1957, p.181, pl.47, fig.7;
pl.53, figs.1,2; pl.57, fig.8; pl.62, figs.5-7.

Berggren, 1960, p.68, pl.I, fig.4; pl.IX, figs. 2-4; pl.X, fig.1, text-fig.7.

Globorotalia mckannai (White), Bolli, 1957, p.79, pl. 19, figs.16-18.

Remarks: This species is identified by its subglo-bular test, moderately convex spiral side, broad open umbilicus, and 5 to 6 globular to ovate chambers in the final whorl gradually increasing in size.

Diameter 0.36 mm.

Occurrence: This species has been recorded from the Velasco formation of Mexico, the Globorotalia velascoensis zone of N.Italy, Globorotalia pseudomenardii zone of the Lizrd Springs formation of Trinidad and from the Paleocene - Lower Eocene formations of United States.

It occurs sparsely in the Lower marlstones and the Discocyclina limestones of the Nerinea formation at localities PT 3 (sample B), PT 7 and PT 11.

Types: R 5232

Globigerina spiralis Bolli

Globigerina spiralis Bolli, 1957, p.70, pl.16, figs.16-18.

Loeblich and Tappan, 1957, p.182, pl.47, fig.3; pl.51, figs.6-9, pl.53, fig.3; Olsson, 1960, p.43, pl.7, figs.19-21; Bolli and Cita, 1960

p.12, pl.XXXII, fig.2.

Remarks: This species is characterised by a high trochospiral test and 4-6 globular chambers in the final whorl.

Diameter 0.16 mm.

Occurrence: Bolli records this species from the Globorotalia uncinata zone of the Lizard Springs formation (Paleocene) of Trinidad. It has also been recorded from the Upper Paleocene of the U.S. Gulf and Atlantic Coastal plains and Lower Paleocene of N.Italy.

This species occurs rarely in the Algal limestones and the Discocyclina limestones of the Nerinea formation at localities PT 6 (sample B), PT 7 and PT9.

Types: R 5233

Globigerina triloculinoides Plummer

Globigerina triloculinoides Plummer, 1926, p.134, pl.8, fig.10. Bolli, 1957, p.70, pl.15, figs.18-20. pl.17, figs.25,26. Troelson, 1957, p.129, pl.30, fig.4. Loeblich and Tappan, 1957, p.183, pl.40, fig.4; pl.41, fig.2; pl.42, fig.2; pl.43, figs.5,8,9; pl.45, fig.3; pl.46, fig.1; pl.47, fig.2; pl.52, figs.3-7; pl.56, fig.8; pl.62, fig. 4. Nagappa, 1959, pl.7, fig.13. Olsson, 1960, p.43

pl.7, figs.22-24.

Globigerina linaperta Finlay, Said and Kenawy (not Finlay), 1956, p.157, pl.7, fig.27.

Remarks: This species is characterised by three to three and a half globular or subglobular rapidly enlarging chambers in the final whorl, the final chamber which occupies almost a half of the test and a prominent apertural lip. Loeblich and Tappan (1957) list several closely resembling species under synonymy.

Greatest diameter 0.36 mm.

Occurrence: This species has a wide geographical distribution. It has been recorded from the Paleocene of the North American Gulf and Atlantic Coastal Plains, Mexico, Denmark, Caucasus region, N.Italy and Egypt. In India it has been recorded from the Danian Langpar Stage of Assam and the Cardita beaumonti beds (Danian) of Sind and Baluchistan.

In Pondicherry this species occurs as a chief element of the microfauna in the Lower marlstones of the Nerinea formation at localities PT 2 and PT 3. It is present also in the Algal limestones of the Nerinea formation at PT 6.

Types: R 5234

Globigerina triplex (Subbotina)

Acarinina triplex Subbotina, 1953, p.230, pl.23, figs.

1-5.

Globigerina primitiva Finlay, Bolli, 1957, p.71, pl.15,
figs.6-8 (not Finlay)

Globigerina triplex Subbotina, Berggren, 1960, p.71, pl.
VI, fig. 2,3; pl.XIII, figs. 1,2.

Remarks: The identifying characters of this species are the medium to large sized trochospiral test, deep open umbilicus, $3\frac{1}{2}$ - 4 rounded subconical rapidly enlarging chambers of the last whorl and the spinose surface.

Greatest diameter 0.33 mm.

Occurrence: This species has been recorded from the Paleocene - Eocene of Northern Caucasus, Trinidad, U.S. Gulf and Atlantic Coastal Plains and Lower Eocene of Denmark and North Western Germany. It occurs commonly in the upper part of the Discocyclina limestones at locality PT 11 and the Upper marlstones of the Nerinea formation at all localities.

Types: R 5235

Globigerina turgida Finlay

Globigerina linaperta var. turgida Finlay, 1939, p.125.

Globigerina turgida Bronnimann, 1952, pp.19-21. pl.3,
figs.1-3. Bolli, 1957, p.73, pl.15, figs.3-5.

Remarks: This species is characterised by a high trochospirally coiled test with chambers slightly flattened peripherally.

Diameter 0.23 mm.

Occurrence: Finlay described this species from the Middle Eocene of New Zealand. It has been recorded also from the Upper Lizard Springs formation and the lower part of the Navet formation of Trinidad.

This species occurs rarely in the Globorotalia pseudo-scitula zone of the Upper marlstones of the Nerinea formation at localities PT 17 and PT 19.

Types: R 5236

Globigerina velascoensis Cushman

Globigerina velascoensis Cushman, 1925, p.19, pl.3, fig.

6. White, 1928, p.196, pl.28, fig.2. Bolli, 1957, p.71, pl.15, figs.9-11.

Remarks: This species is identified by its low trochospiral test with strongly inflated umbilical side, strongly lobate equatorial periphery, rounded axial periphery, 3 - 4 subglobular, laterally compressed, rapidly enlarging

chambers in the last whorl and a low arched aperture with lip.

Diameter 0.26 mm.

Occurrence: This species has been recorded from the Velasco shale of Mexico, Upper part of the Lizard Springs formation of Trinidad, Paleocene of N. Italy etc. It occurs in the Discocyclina limestones of the Nerinea formation at localities PT 7 and PT 9.

Types: R 5237

Globigerina yeguaensis Weinzerl and Applin

Globigerina yeguaensis Weinzerl and Applin, 1929, p.408, pl.43, fig.1a,b. Boll1,1957, p.163, pl.35, figs. 14,15. Berggren, 1960, pp.73-83, pl.II, figs.1-4, pl.III, figs.1-3, pl.4, figs.1,2, pl. VIII, figs. 1-5, text-fig.11.

Remarks: There is considerable variation in the morphological characters of this species. This has led to a great confusion in its proper identification. Berggren (1960 pp.73,74) gives a long list of several species described by authors under synonymy and discusses in detail the extent of morphologic variation this species has undergone. Suffice it to say here that the Pondicherry forms fall within the variational limits of this species. The

normal form of this species is distinctly lobate, has 3 to $3\frac{1}{2}$ rapidly enlarging chambers in the last whorl, has a fairly open umbilicus and a low to high broad interior-marginal umbilical aperture with a delicate lip.

Diameter 0.33 mm.

Occurrence: This is a diagnostic Lower Eocene species. It has been recorded from the Lutetian of Paris basin, Eocene and Oligocene of Mexico, several Eocene localities of U.S.A., Lower and Middle Eocene of northern Caucasus, Lower Eocene of Denmark and N.W. Germany.

This species occurs commonly in the Upper marlstones of the Nerinea formation at all localities.

Types: R 5238

Family GLOBOROTALIIDAE Cushman, 1927

Genus Globorotalia Cushman, 1927

Globorotalia abundocamerata Bolli

Globorotalia angulata abundocamerata Bolli, 1957, p.74,
pl.17, figs.4-6. Bolli and Cita, 1960, p.19,
pl.XXXIII, fig.6.

Remarks: This form shows a definite tendency towards developing into Globorotalia velascoensis and G. aragonensis.

Diameter 0.33 mm. Thickness 0.25 mm.

Occurrence: This species has been recorded from the Paleocene of Trinidad and N.Italy. It is present in the Algal limestones and the Discocyclina limestones of the Nerinea formation at all localities.

Types: Hypotype USNM 641363 R 5239

Globorotalia aequa Cushman and Renz

Globorotalia crassata var. aequa Cushman and Renz, 1942,
p.12, pl.3, fig.3.

Globorotalia aequa Cushman and Renz, Bolli, 1957, p.74,
pl.17, figs.1-3; pl.18, figs.13-15. Loeblich and Tappan, 1957, p.186, pl.46, figs.7,8; pl.50, fig.6;
pl.55, fig.8; pl.59, fig.6; pl.60, fig.3; pl.64,

fig.4. Bolli and Cita, 1960, p.17, pl.XXXI,

fig. 5.

Globorotalia angulata (White), Loeblich and Tappan (not White) 1957, p.187, pl.58, fig.2.

Globorotalia (Truncorotalia) aequa aequa Cushman and Renz, Hillebrandt, 1962, p.133, pl.13, figs.1-4.

Remarks: The identifying characters of this species are the trochospiral test with flat or slightly convex spiral side and strongly convex umbilical side, $3\frac{1}{2}$ to 4 rapidly enlarging chambers in the final whorl with the last chamber relatively very large and the truncate equatorial periphery sometimes with a slight keel.

Greatest diameter 0.30 mm. Thickness 0.21 mm.

Occurrence: This species has been recorded from the Paleocene of Trinidad, N.Italy, Paleocene and Lower Eocene of the U.S. Gulf and Atlantic Coastal Plains. This is a common form in the Nerinea formation occurring in all the zones except the Globorotalia trinidadensis zone.

Types: R 5240

Globorotalia angulata (White)

Globigerina angulata White, 1928, pp.191-192, pl.27, fig.13.

Globorotalia angulata (White), Bolli, 1957, p.74, pl.

17, figs. 7-9. Loeblich and Tappan, 1957, p.187, pl.45, fig.7; pl.48, fig.2; pl.50, fig. 4; pl.55, figs.2,6,7; pl.64 fig.5. Olsson, 1960, p.44, pl. 8, figs.14-16.

Remarks: This species is identified by its plano-convex test, 5 subangular rapidly enlarging chambers in the last whorl and a deep narrow umbilicus.

Diameter 0.38mm. Thickness 0.23 mm.

Occurrence: This species has been recorded from the Paleocene of Trinidad, Mexico, Paleocene and Eocene of the Atlantic Coastal Plain etc. It is of common occurrence in all the zones of the Nerinea formation at all localities except the Globorotalia trinidadensis zone.

Types: R 5241

Globorotalia apantesma Loeblich and Tappan

Globorotalia apantesma Loeblich and Tappan, 1957, p.187, pl.48, fig.1; pl.55, fig.1; pl.58, fig.4; pl.59, fig.1. Olsson, 1960, p.45, pl.8, figs. 17-19.

Remarks: The identifying characters of this species are the trochospiral planoconvex test, acute axial periphery without keel, 4 - 5 somewhat overlapping chambers

in the final whorl and a fairly wide open umbilicus.

Diameter 0.38 mm. Thickness 0.25 mm.

Occurrence: This species has been recorded from the Paleocene and Eocene strata of the U.S. Atlantic Coastal Plain. It occurs sparsely in the Upper marlstones of the Nerinea formation at localities PT 13, 14, 17 and 20.

Types: R 5242

Globorotalia aragonensis Nuttal

Globorotalia aragonensis Nuttal, 1930, p.288, pl.24, figs. 6-8, 10,11. Bolli, 1957, p.75, pl.18, figs. 7-9. Bolli, 1957, p.167, pl.38, fig.1.

Remarks: The identifying characters of this species are the trochospiral plano-convex test, circular equatorial periphery with a distinct slightly spinose keel, 6 - 7 slowly enlarging chambers of the last whorl, slightly raised and beaded spiral sutures and narrow deep and open umbilicus. In the present material transitional forms from Globorotalia abundocamerata to Globorotalia aragonensis are present.

Diameter 0.33 mm. Thickness 0.20 mm.

Occurrence: This species was originally described from the Aragon formation (Eocene) of Mexico. It has been

recorded from the upper part of the Lower Eocene of Cuba, Upper Lizard Springs and Navet formations (Eocene) of Trinidad. This species is of common occurrence in the Upper marlstones of the Nerinea formation at all localities. The transitional forms between Globo-rotalia abundocamerata and G. aragonensis are present in the upper part of the Discocyclusina limestones (Globo-rotalia rex zone) of the Nerinea formation at locality PT 11.

Types: Hypotype USNM 641364 R 5243

Globorotalia broedermanni Cushman and Bermudez

Globorotalia (Truncorotalia) broedermanni Cushman and Bermudez, 1949, p.40, pl.7, figs.22-24.

Globorotalia broedermanni Cushman and Bermudez, Bolli, p.80, pl.19, figs. 13-15; p.167, pl.37, fig.13.

Remarks: This species is characterised by its biconvex low trochospiral somewhat compressed test, circular equatorial periphery, subangular or rounded axial periphery, 5-6 slowly enlarging chambers of the last whorl, curved and depressed spiral sutures and a small open umbilicus.

Diameter 0.28 mm.

Occurrence: This is an Eocene form occurring in Cuba

and Trinidad. It is present in the Upper marlstones of the Nerinea formation at all localities.

Types: R 5244

Globorotalia compressa (Plummer)

Globigerina compressa Plummer, 1926, p.135, pl.8, fig.11.

Troelsen, 1957, p.129, pl.30, fig. 5.

Globorotalia compressa (Plummer), Bronnimann, 1952, p.25, pl.2, figs.19-24. Bolli, 1957, p.77, pl.20, figs. 21-23. Loeblich and Tappan, 1957, p.188, pl.40, fig.5; pl.41, fig.5; pl.42, fig.5, pl.44, figs. 9,10. Olsson, 1960, p.45, pl.8, figs. 20-22.

Remarks: This species is characterised by a slightly compressed biconvex test with usually five chambers in the last whorl, an extra-umbilical umbilical aperture with a slight lip. It differs from Globorotalia ehrenbergi by its less compressed test and absence of keel.

Diameter 0.22 mm.

Occurrence: This species is diagnostic of the Lower Paleocene. It occurs in the Danian of the U.S. Gulf and Atlantic Coastal Plains, the Lower Paleocene of Trinidad and N.Italy, and the Upper Danian of Denmark, Sweden and Caucasus region. It is a common form found in the lower beds of the Lower marlstones of the Nerinea formation

at localities PT 1 and 2.

Types: R 5245

Globorotalia convexa Subbotina

Globorotalia convexa Subbotina, 1953, p.209, pl.17, figs. 2,3; Loblich and Tappan, 1957, p.188, pl.48, fig. 4; pl.50, fig.7; pl.53, figs.6-8; pl.57, figs. 5,6; pl.61, fig.4; pl.63,fig.4. Olsson, 1960, p.45, pl.9, figs. 13-15.

Remarks: This species is characterised by a small biconvex test, rounded peripheral margin and nearly closed umbilicus.

Diameter 0.25 mm

Occurrence: This species was originally described from the Lower Tertiary of Russia. It has been recorded from the Velasco formation (Paleocene) of Mexico and the Paleocene and Eocene formations of the U.S. Gulf and Atlantic Coastal Plains. This species occurs less commonly in the Discocyclina limestones and more commonly in the Upper marlstones of the Nerinea formation at all localities.

Types: R 5246

Globorotalia cf G. densa (Cushman)

Remarks: This form is characterised by four subangular chambers in the last whorl disposed at diametrically opposite sides, angular axial periphery, smoothly rounded umbilical shoulders and a narrow open umbilicus. It shows closest affinity to Globorotalia densa (Cushman).

Greatest diameter 0.25 mm. Thickness 0.18 mm.

Occurrence: This form occurs rarely in the upper part of the Upper marlstones of the Nerinea formation (Globorotalia pseudoscitula zone) at locality PT 17. Globorotalia densa is considered to be diagnostic of the Middle Eocene. It has been recorded from Cuba, Trinidad, and Japan.

Unfigured specimen: R 5247

Globorotalia ehrenbergi Bolli

Globorotalia ehrenbergi Bolli, 1957, p.77, pl.20, figs.

18 - 20.

Remarks: This is a compressed low trochospiral form with five rapidly enlarging chambers in the last whorl, and slightly curved spiral sutures. This species is considered to be a connecting link between Globorotalia compressa and G. pseudomenardii and possibly G. loeblichii.

Long diameter 0.25 mm. Short diameter 0.20 mm.

Occurrence: This species is diagnostic of the Middle

Paleocene. It has been recorded from Trinidad and N. Italy. In the Pondicherry area it occurs commonly in the Lower marlstones and the Algal limestones of the Nerinea formation at localities PT 2, PT 3 (sample B) and PT 6 (sample B).

Types: R 5248

Globorotalia formosa formosa Bolli

Globorotalia formosa formosa Bolli, 1957, p.76, pl.18, figs. 1-3.

Remarks: This subspecies is characterized by a very low trochospiral test, strongly convex umbilical side, lobate peripheral margin with a pronounced spinose keel and 6-7 slowly enlarging chambers.

Greatest diameter 0.38 mm.

Occurrence: This species was originally described from the Upper Lizard Springs formation (Lower Eocene) of Trinidad. It occurs rarely in the Upper marstones of the Nerinea formation at localities PT 13 and 15.

Types: R 5249

Globorotalia formosa gracilis Bolli

pl.3, figs. 11,12

Globorotalia formosa gracilis Bolli, 1957, p.75, pl.18,

figs. 4-6.

Remarks: The Pondicherry forms are identical with the types. This subspecies is characterised by a very low trochospiral test, gently convex spiral side, distinctly convex umbilical side, lobate equatorial periphery, angular axial periphery ornamented with a spinose keel, 5-6 rapidly enlarging chambers in the last whorl, narrow deep open umbilicus and a low arched interio-marginal extraumbilical-umbilical aperture.

Diameter 0.41 mm. Thickness 0.20 mm.

Occurrence: Bolli described this form from the Upper Lizard Springs formation (Lower Eocene) of Trinidad. It occurs very commonly in the Upper marlstones of the Nerinea formation at all localities. In the upper portions of the Upper marlstones, populations of this form contain specimens very close to Globorotalia spinulosa.

Types: Figured hypotype USNM 641365 R 5250

Globorotalia hispidicidaris Loeblich and Tappan

Globorotalia hispidicidaris Loeblich and Tappan, 1957,
p.190, pl.58, fig.1.

Remarks: The Pondicherry form compares well with the types. The identifying characters are the trochospiral test with angularly truncate periphery, 5-7 slowly en-

larging chambers, hispid surface and the spinose peripheral angle giving a keel like appearance.

Diameter 0.36 mm.

Occurrence: This species was described from the Aquia formation (Lower Eocene) of the U.S. Atlantic Coastal Plain. It occurs as a rare form in the Upper marlstones of the Nerinea formation at localities PT 15, 16, 18 and 20.

Types: R 5251

Globorotalia pseudobulloides (Plummer)

pl.2, figs.13,14

Globigerina pseudobulloides Plummer, 1926, p.133, p.8, fig.9. Nagappa, 1959, pl.7, fig.14.

Globorotalia pseudobulloides (Plummer), Bolli, 1957, p.73, pl.17, figs. 19-21. Loeblich and Tappan, 1957, p.192, pl.40, figs.3,9; pl.41, fig.1. pl. 42, fig.3; pl.43, figs.3,4; pl.44, figs.4-6; pl.45, figs. 1-2; pl.46, fig. 6. Olsson, 1960, p.46, pl.9, figs.19-21.

Remarks: This species is characterised by a low trochospiral test with usually five subglobular inflated chambers in the last whorl and an extraumbilical-umbilical aperture with a prominent lip.

Maximum diameter 0.24 mm.

Occurrence: This species has been recorded from seven

ral Lower Paleocene localities. It has been recorded from Trinidad, U.S.Gulf and Atlantic Coastal Plains, N.Italy, and the Caucasus region. It occurs in the Danian of Central Assam (Langpar Stage), Sind and Baluchistan (Cardita beaumonti beds) in the Indian region. It is present in the lower beds of the Lower marlstones of the Nerinea formation at localities PT 1 and 2. Rare specimens of this form occur in the Algal limestones at PT 6.

Types: Hypotype USNM 641366 R 5252

Globorotalia pseudomenardii Bolli

Globorotalia pseudomenardii Bolli, 1957, p.77, pl.20, figs.14-17. Loeblich and Tappan, 1957, p.193, pl.45, fig.10; pl.47, fig.4; pl.49, fig.6; pl.54, figs. 10-13, pl.59, fig.3; pl.60, fig.8; pl.63, fig.1; Olsson, 1960, p.47, pl.9, figs.10-12.
Pseudogloborotalia membranacea (Ehrenberg), Haque, 1956, p.188, pl.22, fig.3.

Remarks: This species is characterised by a low trochospiral biconvex test, angular periphery with a distinct keel, smooth surface, strongly compressed chambers, strongly curved spiral sutures and radial sutures on the umbilical side.

Long diameter 0.33 mm. Short diameter 0.25 mm

Occurrence: This species has been recorded from the Lower Lizard Springs formation (Paleocene) of Trinidad, the Paleocene and Eocene of the U.S. Gulf and Atlantic Coastal Plains, Lower Tertiary of the Caucasus region, Paleocene of N. Italy etc.

This is a common form in the upper part of the Lower marlstones and the Upper marlstones of the Nerinea formation at all localities. It becomes rare in the uppermost part of the Upper marlstones. It is very rare or absent in the Algal limestones and the Discocyclina limestones. This is probably due to some ecologic control.

Types: Hypotype USNM 641367 R5253

Globorotalia pseudoscitula Glaessner

pl.3, figs. 1,2,3

Globorotalia pseudoscitula Glaessner, 1937, pp. 32,49, text-fig. 3. Loeblich and Tappan, 1957, p.193, pl.46, fig.4; pl.48, fig.3; pl.53, fig.5; pl.59, fig.2; pl.63, fig.6.

Remarks: This species is characterised by a biconvex somewhat lenticular test, acute or subacute peripheral margin, nearly closed umbilicus and strongly curved spiral sutures. It differs from Globorotalia convexa in its more acute periphery.

Diameter 0.30 mm.

Occurrence: This species was originally described from the Eocene of Caucasus region. Loeblich and Tappan record the occurrence of this form from the Paleocene and Lower Eocene formations of the North American Gulf and Atlantic Coastal Plains. It occurs as a chief element of the planktonic fauna in the upper part of the Upper marlstones of the Nerinea formation (Globorotalia pseudoscitula zone) at localities PT 17 to PT 20. It is sparsely distributed in the lower part of the Upper marlstones (Globorotalia formosa formosa zone).

Types: Figured hypotype USNM 641368 R 5254

Globorotalia pusilla pusilla Bolli

pl.3, figs. 9,10

Globorotalia pusilla pusilla Bolli, 1957, p.78, pl.20, figs. 8-10.

Remarks: This form is characterised by a compressed biconvex test with an acute or subacute periphery, strongly curved spiral sutures and a narrow open umbilicus.

Diameter 0.25 mm.

Occurrence: This is a diagnostic species of the Middle Paleocene. Bolli originally described this form from the Paleocene of Trinidad. It is found rarely in the upper part of the Lower marlstones and the Algal limestones of the Nerinea formation at localities PT 3

(sample B) and PT 6.

Types: Figured hypotype USNM 641369 R 5255

Globorotalia quadrata (White)

Globigerina quadrata White, 1928, p.195, pl.27, fig. 18.

Globorotalia quadrata (White), Bolli, 1957, p.73, pl.17,
figs.22-24.

Remarks: This species is identified by the very low trochospiral test with 4-5 rapidly enlarging chambers in the last whorl, quadrangular outline and the wide open umbilicus.

Greatest diameter 0.28 mm.

Occurrence: This species has been recorded from the Paleocene (Globorotalia uncinata - G. pseudomenardii zones) of Trinidad. In the Pondicherry area it occurs as a rare form in the Lower marlstones of the Nerinea formation at localities PT 2 and 3.

Types: R 5256

Globorotalia quetra Bolli

Globorotalia quetra Bolli, 1957, p.79, pl.19, figs.1-6.

Remarks: This species is identified by its flat or slightly concave spiral side and angular chambers.

Diameter 0.41 mm. Thickness 0.30 mm.

Occurrence: This species has been recorded from the Upper Lizard Springs formation (Lower Eocene) of Trinidad. It occurs sparsely in the upper part of the Upper marlstones of the Nerinea formation at localities PT 17 and 19.

Types: R 5257

Globorotalia rex Martin

pl.3, figs. 17,18

Globorotalia rex Martin, 1943, p.117, pl.8, fig. 2.

Bolli, 1957, p.75, pl.18, figs. 10-12. Loeblich and Tappan, 1957, p.195, pl.60, fig.1.

Remarks: This species is identified by its planoconvex test with four rapidly enlarging chambers in the last whorl and the angular axial periphery with a distinct keel.

Diameter 0.31 mm.

Occurrence: This species has been recorded from the Lodo formation (Lower Eocene) of California, Lower Eocene of Trinidad and the U.S. Gulf and Atlantic Coastal Plains.

It occurs commonly in the Discocyclina limestones and the Upper marlstones of the Nerinea formation at all localities.

Types: Figured hypotype USNM 641370 R 5258

Globorotalia trinidadensis Bolli

pl.2, figs. 15,16

Globorotalia trinidadensis Bolli, 1957, p.73, pl.16,
figs. 19-23.

Remarks: The Pondicherry forms compare well with the holotype and paratypes. This species is characterised by 5-7 globular slowly enlarging chambers in the last whorl.

Diameter 0.21 mm.

Occurrence: This species is diagnostic of the Lower Paleocene. Bolli described it from the Lower Paleocene of Trinidad. In the Pondicherry area it occurs in the lower beds of the Lower marlstones of the Nerinea formation at localities PT 1 and 2.

Types: Figured hypotype USNM 641371 R 5259

Globorotalia uncinata Bolli

pl.3, figs. 22,23

Globorotalia uncinata Bolli, 1957, p.74, pl.17, figs.
13-15.

Remarks: This species is characterised by its low trochospiral test with subangular chambers, strongly curved spiral sutures and the narrow deep umbilicus. This species is considered to be the connecting link between Globorotalia pseudobulloides and G. angulata.

Diameter 0.27 mm.

Occurrence: This form is characteristically present in strata just above the zone of Globorotalia daubjergensis. It occurs in the Lower Paleocene of Trinidad. In the Pondicherry area this species is restricted to the lower beds of the Lower marlstones of the Nerinea formation at locality PT 2. It occurs in association with Globorotalia ehrenbergi, G. pseudobulloides, G. compressa, G. whitei, G. angulata, G. aequa, Globigerina triloculinoides, and transitional forms between Globorotalia uncinata and G. angulata.

Types: Figured hypotype USNM 641372 R 5260

Globorotalia velascoensis (Cushman)

pl. 3, figs. 13, 14

Pulvinulina velascoensis Cushman, 1925, p. 19, pl. 3, fig. 5

Globorotalia velascoensis (Cushman), Le Roy, 1953, p. 33,

pl. 3, figs. 1-3. Bolli, 1957, p. 76, pl. 20, figs.

1-4. Loeblich and Tappan, 1957, p. 196, pl. 64,

figs. 1, 2.

Globorotalia velascoensis (Cushman), Haque, 1956, p.181,
pl.24, fig.2

Globorotalia aragonensis caucasica Glaessner, 1937,
p.31, pl.1, fig.6.

Globorotalia (Truncorotalia) crater Finlay, Hornibrook,
1958, (Not Finlay), p.33, pl.1, figs. 3-5.

Remarks: Basically this species is characterised by a large open umbilicus, strongly thickened and ornate umbilical shoulder which is often recurved away from the umbilicus, beaded spiral sutures and the spinose or beaded peripheral keel. In the number of chambers there is considerable variation from 5 to 9. Immature specimens are relatively more conical. Large and mature tests are slightly concave at the side.

Diameter 0.56 mm Thickness 0.26 mm.

Occurrence: This species has been recorded from the Paleocene of Mexico, Trinidad, N.Italy, and the Lower Eocene of Russia etc. In India it has been recorded from the Laki (Lower Eocene) of the Nammal Gorge of Salt Range. In the Pondicherry area it occurs commonly in the Disco-cyclina limestones and the Upper marlstones of the Nerinea formation at all localities. In the upper part of the Globorotalia whiteli zone Globorotalia abundocamerata shows tendency towards developing into G. velascoensis.

Globorotalia velascoensis occurs as a rare form in the G. velascoensis zone. It is well developed and occurs more commonly in the G. rex and higher zones associated with such diagnostic Early Eocene forms like G. rex, G. formosa gracilis, G. aragonensis, G. pseudoscitula etc.

Types: Figured hypotype USNM 641373 R 5261

Globorotalia whitei Weiss

pl.3 figs. 15,16

Globigerina crassaformis Galloway and Wissler, White,

1928, p.193, pl.27, fig. 14

Globorotalia whitei, Weiss, 1955, pp.18,19, pl.6, figs.

1-3. Bolli, 1957, p.79, pl.19, figs. 10-12,

Remarks: This species is characterised by a very low trochospiral test, inflated umbilical side, rounded to subacute axial periphery, 4-5 slightly laterally compressed moderately enlarging chambers in the final whorl, oblique spiral sutures and a fairly narrow umbilicus.

Greatest diameter 0.40 mm Thickness 0.25 mm.

Occurrence: This species was originally described from the Paleocene of Peru. Bolli records it from Trinidad.

In the Pondicherry area this form occurs sparsely in the Globorotalia uncinata zone of the Nerinea formation (locality PT 2). In the upper part of the Lower marlstones and in the Algal limestones it occurs as a chief element of the planktonic fauna. It becomes extinct at the base of the Discocyclina limestones. This form appears to be restricted to tropical areas as Peru, Trinidad and South India. It has not been recorded

from regions of higher latitudes.

Types. Figured hypotype USNM 641374 R 5262

Globorotalia wilcoxensis Cushman and Ponton

pl.3 figs. 20, 21

Globorotalia wilcoxensis Cushman and Ponton, 1932, p.71,

pl.9, fig.10. Bolli, 1957, p.79, pl.19, figs.7-9.

Remarks: The identifying characters of this species are the low trochospiral, planoconvex test, subacute periphery, lobulate peripheral margin, deep open umbilicus, four gradually enlarging chambers in the final whorl and the long tapering interiomarginal extraumbilical-umbilical aperture.

Diameter 0.33 mm.

Occurrence: This is a diagnostic Lower Eocene form. It has been recorded from the Wilcox formation (Lower Eocene) of U.S.A, Upper Lizard Springs formation of Trinidad and Ypresian of Denmark. It occurs as a rare form in the Upper marlstones of the Nerinea formation at locality PT 14.

Types: Figured hypotype USNM 641375 R 5263

Globorotalia imitata Subbotina

Globorotalia imitata Subbotina, 1953, p.206, pl.16,
figs. 14-16. Loeblich and Tappan, 1957, p.190,
pl.44, fig.3; pl.45, fig.6; pl.54, figs.8,9;
pl.59, fig.5; pl.63, fig.3. Olsson, 1960,
p.46, pl.9, figs. 7-9.

Remarks: This species is identified by its small size, the nearly flattened spiral side, the almost truncated periphery and the smooth surface.

Diameter 0.23 mm.

Occurrence: This species was originally described from the Danian of Russia. It has been recorded from the Paleocene and Lower Eocene of U.S. Gulf and Atlantic Coastal Plains. It is sparsely distributed in the Discocyclina limestones and the Upper marlstones of the Nerinea formation at all localities.

Types: R 5264

Globorotalia nammalensis (Haque)

Woodella nammalensis Haque, 1956, p.195, pl.18, figs.

1 and 7.

Remarks: This form compares well with the description and figures published by Haque. The writer considers this species to belong to Globorotalia. The diagnostic characteristics of this species are the conical shape of the test, flat spiral side, strongly convex umbilical side, sharply lobate equatorial periphery, angular axial periphery with a distinct fine keel, the 5 to 6 gradually enlarging chambers of the last whorl, each sharply drawn out to form a longitudinal ridge on the umbilical side, the markedly depressed sutures on the umbilical side, the very narrow deep umbilicus almost closed by the incurved ridges on the umbilical shoulder, and the very low interiomarginal extraumbilical umbilical apertural slit.

Haque (1956) considers this species to resemble Rotalia calcariformis (Discorbina calcariformis Schwager (1883) from the Eocene of Libyan Desert). It does not appear to be so. This species resembles Globorotalia formosa gracilis Bolli in its lobulate periphery but is more conical in shape and smaller in size. It resembles Globoro-

talia aragonensis Nuttal, in its conical shape but has a more closed umbilicus and smoother chamber surface. It resembles Globorotalia inconspicua Howe from the Louisiana Cook Mountain Eocene but differs from it in the more closed umbilicus. This species appears to have a general affinity to the conical globorotalid species that characterise the Early Eocene. It apparently is a member of the evolutionary lineage Globorotalia rex, G. formosa gracilis and G. aragonensis.

Diameter: 0.21 mm.

Occurrence: Haque described this species from the L. Eocene of Salt Range, Pakistan where it occurs restricted to the Patala shales. In the Pondicherry area it is a very rare form occurring in only one locality (PT 14) in the Upper marlstones of the Nerinea formation.

Types: Hypotype USNM 641376 R 5265

Globorotalia pondicherriensis Rajagopalan n.sp.

pl.3 figs. 6,7,8

Description: Test small, very low trochospiral, chambers of the earlier whorls on the spiral side as a rule slightly sunken within the chambers of the last whorl, in some specimens the spiral side is gently convex, equatorial periphery lobate, axial periphery broadly rounded to slightly compressed; wall calcareous, perforate, surface smooth or slightly hispid; chambers inflated, globular to slightly compressed laterally, 4 - 4½ chambers in the final whorl rapidly increasing in size; sutures on the spiral side radial or slightly oblique, depressed, radial and depressed on the umbilical side; umbilicus narrow, open; aperture a broad arch, interiomarginal extraumbilical umbilical.

Diameter of the holotype 0.33 mm.

Occurrence: This form makes its first appearance at the base of the Discocyclina limestones. It is a chief element of the planktonic microfauna in the Discocyclina limestones and the Upper marlstones of the Nerinea formation at all localities. It becomes a rare element in the uppermost beds of the Upper marlstones (loc. PT 19).

Holotype USNM 641377 Paratypes USNM 641378 R 5266 from locality PT 13.

Remarks: This species has a close affinity to Globi-

gerina collactea Finlay and G. prolata Bolli but differs from them in its chamber shape which is more elongated along the axis of coiling and somewhat laterally compressed, its aperture which is distinctly extraumbilical in position and its much smaller umbilicus.

Globorotalia loeblich Rajagopalan n.sp.

Globorotalia elongata Glaessner. Loeblich and Tappan, 1957, (not Glaessner), p.189, pl.45 fig.5; pl. 46 fig.5; pl.48 fig.5; pl.49 fig.7; pl.54 figs.1-5; pl.59 fig.4; pl.60 fig.9; pl.63 fig.2. Bolli 1957, p.77, pl. 20 figs.11-13. Olsson 1960 p.45, pl.9 figs.4-6.

Globorotalia compressa (Plummer), Toulmin 1941, p.607, pl. 82 figs.1,2.

Remarks: The forms described by Loeblich and Tappan (1957), Bolli (1957) and other authors as Globorotalia elongata from North America are considered not synonymous with Globorotalia pseudoscitula var. elongata Glaessner described from the Lower Tertiary of the Caucasus region. Glaessner's variety 'elongata' is supposed to be a keeled form closely related to G. pseudoscitula. Hence this new name is proposed for forms described by Loeblich and Tappan and other authors.

Types: The hypotype of Globorotalia elongata deposited by Loeblich and Tappan under USNM P5133 a is chosen as the holotype of this species. Their other hypotypes of G.elongata bearing the numbers USNM P5813, P5692, P5693, P5697, P5133b-e, P5695, P5694 and P5882 are selected as paratypes.

Occurrence: This species occurs commonly in the Paleocene and L. Eocene of the U.S. Atlantic Coastal Plain and the Paleocene of Trinidad. In the Pondicherry area primitive forms of this species which are difficult to be distinguished from Globorotalia ehrenbergi, occur in the basal part of the Nerinea formation at locality PT 2. Well developed and typical forms appear higher in the section (loc. PT 3). This species occurs commonly throughout the Nerinea formation at all localities. In the upper part of the Upper marlstones (zone of Globorotalia pseudoscitula) the chambers become more inflated. In the uppermost part (loc. PT 19) this species is scarce.

Family HANTKENINIDAE Cushman 1927

Genus Pseudohastigerina Banner and Blow 1959

Pseudohastigerina wilcoxensis (Cushman and Ponton)

Nonion wilcoxensis Cushman and Ponton, 1932, p.64, pl.8,
figs. 11 a,b.

Hastigerina eocenica Berggren, 1960, p.85, pl.5, figs.
1a - 2c, pl.10, figs. 2a - c.

Pseudohastigerina eocenica (Berggren), Pokorny 1960,
pl.4, figs. 3 - 5.

Remarks: This species is identified by its planispiral, biumbilicate test and the equatorial aperture. In the present material there is a solitary specimen with double aperture.

Occurrence: This species was originally described from the Eocene of U.S. Gulf Coastal Plain. It occurs in the Lower Eocene of N.W.Germany and of Czechoslovakia. In the Pondicherry area this form is present in the upper part of the Discocyclina limestones (Globorotalia rex zone) and the Upper marlstones at all localities.

Types: Hypotype USNM 641379 R 5267

BENTHONIC FORAMINIFERA

Family LAGENIDAE

Genus *Chrysalogonium* Schubert, 1907*Chrysalogonium arkansanum* Cushman and Todd

Chrysalogonium arkansanum Cushman and Todd, 1946, p.52,
pl.9, figs. 1,2.

Occurrence: This species has been recorded from the Paleocene formations of the North American Gulf Coastal Plain. It occurs rarely in the Lower marlstones and the Upper marlstones of the Nerinea formation at localities PT 1, 3, 13, 14, 15.

Types: R 5269

Genus *Citharina* d'Orbigny, 1839*Citharina plumoides* (Plummer)

Vaginulina plumoides Plummer, 1926, p.120, pl.5, fig.4.
Citharina plumoides (Plummer), Brotzen, 1948, p.45,
pl. 5, figs. 4,5.

Occurrence: This species has been recorded from the Paleocene of the U.S. Gulf Coast, Sweden and Holland. It occurs very rarely in the Lower marlstones of the Nerinea formation at locality PT 3.

Types: R 5270

Genus Dentalina d'Orbigny, 1826

Dentalina colei Cushman and Dusenbury

Dentalina colei Cushman and Dusenbury, 1934, p.54, pl.7,
figs. 10-12. Toulmin, 1941, p.584, pl.79, fig.12.

Occurrence: This species has been reported from the Paleocene and Eocene of the North American Gulf and Atlantic Coastal Plains and Egypt. It occurs rarely in the Algal limestones of the Nerinea formation at locality PT 6.

Types: R 5271

Dentalina crosswickensis Olsson

Dentalina crosswickensis Olsson, 1960, p.15 pl.3, figs.
3,4.

Occurrence: Olsson records this species from the Hornestown formation (Upper Paleocene - Lower Eocene) of the New Jersey Coastal Plain of North America. Rare specimens of this species identical to the holotype and paratypes are present in the Nerinea formation at localities PT 3 (sample B), PT 11 and 13.

Types: R 5272

Dentalina gardnerae (Plummer)

Marginulina gardnerae Plummer, 1926, p.106, pl. V, figs.

11 a-c.

Dentalina gardnerae (Plummer), Toulmin, 1941, p.585,
pl.79, fig. 15. Cushman and Todd, 1946, p.49,
pl.8, fig. 1.

Occurrence: This species has been recorded from the Paleocene and Lower Eocene of the U.S. Gulf Coast. In Pondicherry it occurs rarely in the Discocyclina limestones of the Nerinea formation at locality PT 11.

Types: R 5273

Dentalina pseudoaculeata Olsson

Dentalina aculeata Cushman, 1946 (not d'Orbigny), p.67,
pl.26, figs. 17,18.

Dentalina (?) pseudoaculeata Olsson, 1960, p.14, pl.3,
figs. 1,2.

Occurrence: Olsson records this form from the Upper Cretaceous, Paleocene and Lower Eocene of the U.S. Atlantic Coastal Plain. It occurs in the Upper Cretaceous of Texas and California also. In the Pondicherry area it is present in the Lower marlstones and the Upper marlstones of the Nerinea formation at PT 1 and 13.

Types R 5274

Dentalina soluta Reuss

Dentalina soluta Reuss, 1851, p.60, pl.3, fig.4.

Toulmin, 1941, p.587, pl.79, figs. 23,24.

Nodosaria soluta (Reuss), Plummer, 1927, p.78, pl.4,
fig. 10.

Occurrence: This species is of wide geographical distribution in the Upper Cretaceous, and Paleocene strata. It occurs very rarely in the Lower marlstones and the Upper marlstones of the Nerinea formation at localities PT 3 and PT 18.

Types: R 5275

Dentalina vertebralis (Batsch)

Nautilus (Orthoceras) vertebralis Batsch, 1791, p.3,
pl.2, fig. 6.

Dentalina vertebralis (Batsch), Toulmin, 1941, p.587,
pl.79, fig. 25.

Occurrence: This species has been recorded from the Paleocene of the U.S. Gulf Coast, Eocene of Mexico and England. It is a recent form occurring in the Mediterranean. A few specimens of this form are present in the Lower marlstones of the Nerinea formation at locality PT 3.

Types: R 5276

Genus Frondicularia DeFrance, 1826

Frondicularia frankel Cushman

Frondicularia frankel Cushman, 1936, p.18, pl.4, figs.
6,7.

Occurrence: This species occurs in the Maestrichtian of the North American Gulf Coast. It has been recorded from the Maestrichtian of Egypt. In the Pondicherry area a few typical specimens of this form are found in the Upper marlstones of the Nerinea formation at locality PT 13,

Types: R 5277

Frondicularia goldfussi Reuss

Frondicularia goldfussi Reuss, 1860, p.192, pl.4. fig.7.
Cushman, 1946, p.87, pl.34, figs. 18-20, pl.35,
figs. 1,2.

Occurrence: This form occurs in the Upper Cretaceous of the North American Gulf Coast and in the Maestrichtian of Egypt. A few rare specimens of this species are found in the Upper marlstones of the Nerinea formation at locality PT 13.

Types: R 5278

Frondicularia midwayensis Cushman

Frondicularia midwayensis Cushman, 1940, p.63, pl.10,
figs. 34, 35. Cushman, 1951, p.30, pl.9, figs.4,5.
Olsson, 1960. p. 22 pl.3, fig. 18.

Occurrence: This species has been recorded from the Paleocene of the North American Gulf and Atlantic Coastal Plains. In the Pondicherry area it occurs rarely in the Lower marlstones and the Upper marlstones of the Nerinea formation at localities PT 3, 15 and 16.

Types: R 5279

Frondicularia naheolensis Cushman and Todd

Frondicularia naheolensis Cushman and Todd, 1942, p.33,
pl.6, figs. 5,6. Cushman, 1951, p.30, pl.8,
figs. 24,25.

Occurrence: This species has been recorded from the Paleocene of the North American Gulf Coast. One or two occasional specimens are found in the Upper marlstones of the Nerinea formation at locality PT 16.

Types: R 5280

Genus Lagena Walker and Boys, 1784

Lagena cf L. costata (Williamson)

Entosolenia costata Williamson, 1858, p.9, pl.1, fig.18.

Lagena costata (Williamson), Cushman, 1932, p.59, pl.7,
fig. 21.

Remarks: The present form is very similar to Cushman's figure except for a slight flattening at the top and bottom so much so the short slender neck appears to be lodged in a depression.

Occurrence: This form is present in the Nerinea formation at localities PT 11, 17 and 20.

Types: R 5281

Lagena sulcata semiinterrupta Berry

Lagena sulcata (Walker and Jacob) Parker and Jones var.

semiinterrupta Berry, 1929, p. 5, pl.3, fig.19.

Cushman, 1951, p.31, pl.9, figs. 10,11. Olsson,
1960, p.23, pl.3, fig.22.

Occurrence: This form has been recorded from the Upper Cretaceous, Paleocene and Lower Eocene of the North American Gulf and Atlantic Coastal Plains. Rare specimens of this form occur in the Trigonarca formation at PK 8 and in the Nerinea formation at almost all localities.

Types R 5282

Genus Marginulinopsis Silvestri 1904

Marginulinopsis cf M. silicula (Plummer)

Hemicristellaria silicula Plummer, 1931, p.148, pl.10,
figs. 8,9.

Marginulinopsis silicula (Plummer), Cushman, 1946, p.62,
pl.21, figs. 42-45

Occurrence: This form has been recorded from the Upper Cretaceous of Bavaria, Columbia and the Maestrichtian of the U.S. Gulf Coast. In the Pondicherry material there is only one broken specimen available. It is from the Trigonarca formation, locality PK 8.

Type: R 5283

Genus Marginulina d'Orbigny 1926.

Marginulina bullata Reuss

Marginulina bullata Reuss, 1845, p.29, pl.13, figs.34-38.
Cushman, 1946, p.62, pl.21, figs. 32-37.

Occurrence: This species has been recorded from the Upper Cretaceous of the U.S. Gulf Coast. A few specimens of this form are present in the Valudavur formation at locality PK 7.

Types: R 5284

Genus Nodosaria Lamarck 1812

Nodosaria affinis Reuss

Nodosaria affinis Reuss, 1845, p.26, pl.XIII, fig. 16.

Cushman, 1946, p.70, pl.25, figs. 8-23. Cushman,
1951, p.23, pl.7, figs. 3-6. Said and Kenawy,
p.133, pl.2, fig.30.

Occurrence: This species has been widely recorded from Cretaceous and Lower Tertiary deposits of Europe and North America. It occurs rarely in the Paleocene - Eocene of Egypt. In the Pondicherry area this form occurs rarely in the Upper marlstones of the Nerinea formation at localities PT 15 and 16.

Types: R 5285

Nodosaria latejugata Gümbel

Nodosaria latejugata Gümbel, 1870, p.619, pl.1, fig.32

Cushman, 1951, p.23, pl.7, figs. 1-2.

Occurrence: This species has been recorded from the Lower Paleocene deposits of the U.S. Gulf Coast. A few broken specimens of this form are found in the sample from locality PK 7 (Valudavur formation).

Types: R 5286

Nodosaria macneilli Cushman

Nodosaria macneilli Cushman, 1944, p.37, pl.6, fig.9.

Cushman, 1951, p.24, pl.7, fig.7.

Occurrence: This species has been recorded from the Paleocene of the U.S. Gulf Coast. In the Pondicherry area it occurs rarely in the Lower marlstones and the Discocyclusina limestones of the Nerinea formation at localities PT 1, 3, 8 and 11.

Types: R 5287

Nodosaria obscura Reuss

Nodosaria obscura Reuss, 1845, p.26, pl.13, figs. 7-9.

Cushman, 1946, p.73, pl.26, figs. 15,16.

Occurrence: This species occurs in the Upper Cretaceous of the U.S. Gulf Coast. It occurs rarely in the Valudavur formation at locality PK 7.

Types: R 5288

Genus Planularia DeFrance, 1824Planularia toddae Cushman

Planularia toddae Cushman, 1944, p.34, pl.5, fig.12.

Cushman, 1951, p.16, pl.5, figs. 5-8.

Occurrence: This species occurs in the Paleocene of

the U.S. Gulf Coast. It is present in the Nerinea formation at localities PT 3, 13 and 15.

Types: R 5289

Genus Robulus Montfort 1808

Robulus alabamensis Cushman

Robulus alabamensis Cushman, 1944, p.33, pl.5, fig. 13

Cushman, 1951, p.15, pl.4, figs. 15,16.

Occurrence: This species has been recorded from the Paleocene of the U.S. Gulf Coast. It is present in the Lower marlstones of the Nerinea formation at locality PT 3.

Types: R 5290

Robulus inornatus (d'Orbigny)

Robulina inornata d'Orbigny, 1846, p.102, pl.4, figs.

25,26

Robulus inornatus (d'Orbigny), Toulmin, 1941, p.577, pl.

78, fig.19, text-fig. 2B

Occurrence: This species was described from the Tertiary of Vienna basin. It occurs in the Lower Eocene of the U.S. Gulf Coast and the Lower Oligocene of Mexico. It is frequently found in the Discocyclina limestones and the lower part of the Upper marlstones at almost all

localities.

Types: R 5291

Robulus insulsus Cushman

Cristellaria orbicularis Plummer (not d'Orbigny), 1927,
p.92, pl.7, fig.1.

Robulus insulsus Cushman 1947, p.83, pl.18, figs.2,3.
Cushman, 1951, p.16, pl.5, figs. 1-3.

Occurrence: This species was described from the Paleocene of the U.S. Gulf Coast. It occurs commonly in the Lower marlstones of the Nerinea formation at locality PT 3.

Types: R 5292

Robulus rosettus (Gümbel) Cushman

Robulina rosetta Gümbel, 1870, p.642, pl.1, fig. 73.
Robulus cf R. rosettus (Gümbel) Cushman, 1951, p.16,
pl.4, figs. 20-21.

Occurrence: This species was described from the Lower Eocene of Bavaria. It occurs in the Paleocene of Trinidad and the U.S. Gulf Coast. In Pondicherry it is present in the Upper marlstones of the Nerinea formation at locality PT 13.

Types: R 5293

Robulus turbinatus (Plummer)

Cristellaria turbinata Plummer, 1927, p.93, pl.7, fig.4.

Robulus turbinatus (Plummer) Cushman, 1940, p.55, pl.9,

fig.17. Cushman, 1951, p.14, pl.4, figs. 6-9.

Olsson, 1960, p.10, pl.2, fig.2.

Occurrence: This species has been recorded from the U.S. Gulf and Atlantic Coastal Plains and Egypt from the Paleocene. In Pondicherry it occurs frequently in the Nerinea formation at localities PT 3 (sample B), PT 11 and 13.

Types: R 5294

Robulus wilcoxensis Cushman and Ponton

Robulus wilcoxensis Cushman and Ponton, 1932, p.52,

pl.7, fig.3. Toulmin, 1941, p.579, pl.78, fig.24,

25, text-fig. 2H. Cushman, 1951, p.15, pl.4,

fig.17.

Occurrence: This species has been described from the Paleocene and Lower Eocene of the U.S. Gulf Coast. In the Pondicherry area it is present in the Upper marlstones of the Nerinea formation at locality PT 13.

Types: R 5295

Robulus midwayensis (Plummer)

Cristellaria midwayensis Plummer, 1927, p.95, pl.13,
fig. 5.

Lenticulina midwayensis Plummer, 1933, p.54, 61 and 64.

Robulus midwayensis Cushman, 1940, p.54, pl.9, fig.12;

Toulmin, 1941, p.579, pl.78, fig.23, text-fig.

2g. Cushman 1951, pl.3, figs. 14-17.

Occurrence: This species occurs very commonly in
the Paleocene of the U.S. Gulf Coast. It is present in
the Lower marlstones of the Nerinea formation at locality
PT 3.

Types: R 5296

Genus Saracenaria Defrance 1824

Saracenaria triangularis (d'Orbigny)

Cristellaris triangularis d'Orbigny, 1840, p.27, pl.2,
figs. 21-22.

Saracenaria triangularis (d'Orbigny), Cushman, 1946,
p.58, pl.28, figs.1-3. Said and Kenawy, 1956,
p.131, pl.3, fig. 1

Occurrence: This species has been widely recorded from the Upper Cretaceous viz: Paris Basin, U.S. Gulf Coast, Egypt etc. In the Pondicherry area it occurs rarely in the Nerinea formation at localities PT 3, 6 and 13, and in the Trigonarca and Valudavur formations.

Types: R 5297

Genus Vaginulinopsis Silvestri, 1904

Vaginulinopsis exquisita Toulmin

Vaginulinopsis exquisita Toulmin, 1941, p.583, pl.79,
fig. 7

Toulmin described this species from the Salt Mountain limestone (Lower Eocene) of Alabama, U.S.A. It occurs rarely in the Lower marlstones of the Nerinea formation at localities PT 2 and 3.

Types: R 5298

Genus Vaginulina d'Orbigny 1826

Vaginulina longiforma(Plummer)

Cristellaria longiforma Plummer, 1927, p.102, pl.13,
fig. 4.

Vaginulina longiforma (Plummer) Cushman, 1944, p.38.
pl.6, figs. 11-13.

Occurrence: This species has been recorded from the Paleocene of the U.S. Gulf and Atlantic Coastal Plains. Both megalospherica and microspheric forms of this species are present in the Discocyclina limestones and Upper marlstones of the Nerinea formation at almost all localities.

Types: R 5299

Family POLYMORPHINIDAE

Genus Globulina d'Orbigny 1826

Globulina lacrima Reuss

Polymorphina (Globulina) lacrima Reuss, 1945, p.40, pl.

12, fig. 6; pl.13, fig.83

Globulina lacrima Reuss, Cushman, 1946, p.96, pl.40,

figs. 11,12

Occurrence: This species occurs in the Upper Cretaceous and Paleocene of Europe and North America. It is sparsely distributed throughout the Upper Cretaceous, Paleocene and Lower Eocene formations of the Pondicherry area.

Types: R 5300

Genus Guttulina d'Orbigny 1826

Guttulina communis d'Orbigny

Polymorphina (Guttulina) communis d'Orbigny, 1826, p.

266, pl. 12, figs. 1-4.

Guttulina communis d'Orbigny, Brotzen, 1948, p.49, text-

figs. 10, 6.

Occurrence: This species has been widely recorded from the Upper Cretaceous and Tertiary strata. In the Pondicherry area it is of frequent occurrence at all the fossiliferous localities.

Genus Ramulina Rupert Jones, 1875

Ramulina globulifera Brady

Ramulina globulifera Brady, 1879, p.272, pl.8, figs.
32,33. Toulmin, 1941, p.596, pl.80, fig. 21.

Occurrence: Stray specimens of this species are present in the Valudavur formation at locality PK 6 (sample A), and in the Nerinea formation at localities PT 11, 13, 18 and 3.

Types: R 5301

Family BULIMINIDAE

Genus Aeolostreptis Loeblich and Tappan 1957

Aeolostreptis marylandicus Nogan

Aeolostreptis marylandicus Nogan, 1962, p.152, pl.2,
figs. 16,17.

Occurrence: This appears to be a good index species of the Danian. Nogan first described this species from the basal Aquia formation of U.S.A. It occurs also in the Brightseat (Danian). This form is of common occurrence in the basal beds of the Nerinea formation at locality PT 1.

Types: R 5302

Genus Aragonia Finlay 1939.

Aragonia compressa (Olsson)

Bolivinoidea compressa Olsson, 1960, p.30, pl.4, fig.

20,21.

Occurrence: Olsson described this species from the Paleocene of the New Jersey Coastal Plain U.S.A. It is present in the Algal limestones of the Nerinea formation at locality PT 6.

Types: R 5303

Genus Bulimina d'Orbigny 1826

Bulimina midwayensis Cushman and Parker

Bulimina arkadelphia Cushman and Parker var. midwayensis Cushman and Parker, 1936 p.42, pl.7, figs.9,10.

Bulimina midwayensis Cushman and Parker. Brotzen, 1948, p.58, pl.10, fig.8

Occurrence: This species has been recorded from the Paleocene of Denmark and Sweden and the Paleocene of Texas and New Jersey in the U.S.A. In the Pondicherry area it is present in the Lower marlstones and the Algal limestones of the Nerinea formation at localities PT 2 and 6.

Types: R 5304

Bulimina ovata d'Orbigny

Bulimina ovata d'Orbigny, 1846, p.185, pl.11, figs.13,14,
Cushman, 1932, p.67, pl.9, figs. 1,2.

Occurrence: This species is of wide geographical distribution. It ranges in age from Eocene to Recent. In the Pondicherry area it is of common occurrence in almost all the localities of the Nerinea formation.

Types: R 5305

Bulimina referata Jennings

Bulimina referata Jennings, 1936, p.31, pl.3, fig.21.

Occurrence: This species was described from the Upper Cretaceous formations of the U.S. Atlantic Coastal Plain. It has not been recorded from the Lower Tertiary. In Pondicherry it occurs commonly throughout the Nerinea formation.

Types: R 5306

Bulimina virginiana (Cushman)

Angulogerina virginiana Cushman, 1944, p.25, pl.4, fig.23.
Bulimina pseudocacumenata Olsson, 1960, p.33, pl.5, fig.5.

Occurrence: This species has been recorded from the Paleocene and Lower Eocene of the U.S. Atlantic Coastal

Plain. In the Pondicherry area this form is present in the Upper marlstones of the Nerinea formation at localities PT 13, 14, 15 and 20.

Types: R5307

Genus Loxostomum Ehrenberg 1854

Loxostomum applinae (Plummer)

Bolivina applini Plummer, 1927, p.69, pl.4, fig. 1.

Loxostomum applinae (Plummer) Nuttall, 1930, p.285, pl. 24, figs. 4,5. Cushman, 1951, p.43, pl.12, fig. 18.

Occurrence: This species was described from the Paleocene of the U.S. Gulf Coast region. It is of rare occurrence in the lower beds of the Lower marlstones of the Nerinea formation at locality PT 2.

Types: R 5308

Loxostomum plaitum (Carsey)

Bolivina plaitum Carsey, 1926, p.26, pl.4, fig. 2.

Loxostomum plaitum (Carsey), Cushman, 1946, p.130, pl.54, figs. 10-14.

Occurrence: This species occurs in the Upper Cretaceous of the U.S. Gulf Coast. It is of common occurrence in the Valudavur formation at all localities.

Types: R 5309

Genus Bolivina d'Orbigny 1839

Bolivina crenulata Cushman

Bolivina crenulata Cushman 1936, p.50, pl.17, fig.13.

Occurrence: The types are from the Upper Eocene of Hungary. This form occurs very rarely in the Lower marlstones of the Nerinea formation at locality PT 2.

Types: R 5310

Genus Siphogenerinoides Cushman 1927

Siphogenerinoides eleganta (Plummer)

Siphogenerina eleganta Plummer, 1927, p.126, pl.8, fig.1.

Siphogenerinoides eleganta (Plummer), Cushman, 1940,

p.66, pl.11, fig. 17. Olsson, 1960, p. 31

pl.4, fig. 24.

Occurrence: This is a Paleocene form. It has been recorded from the U.S. Gulf and Atlantic Coastal Plains, Paleocene of Trinidad and Egypt. It is present in the Lower marlstones of the Nerinea formation at locality PT 3.

Types: R 5311

Genus Tappanina Gallitelli 1956

Tappanina selmensis (Cushman)

Bolivinita selmensis Cushman, 1933, p.58, pl.7, figs.3,4.

Brotzen, 1948, p.56, pl.9, fig.7, text-fig.16.

Tappanina selmensis Gallitelli, 1956, p.37, pl.7, figs.

3,4.

Occurrence: This species is distributed in beds of Late Cretaceous age through the Eocene. It has been recorded from the Upper Cretaceous, Paleocene and Lower Eocene of the U.S. Atlantic Coastal Plain, Paleocene of

Sweden and Germany. In the Pondicherry area this form is of very rare occurrence in the Valudavur formation at locality PK 7. It occurs more commonly in the Lower marlstones and the Algal limestones at all localities. There are one or two stray occurrences of this species in the Upper marlstones.

Types: R 5312

Genus Virgulina d'Orbigny 1826

Virgulina wilcoxensis Cushman and Ponton

Virgulina wilcoxensis Cushman and Ponton, 1932, p.67,
pl.8, fig. 22. Cushman, 1951, p.42, pl.12,
figs. 8,9.

Occurrence: This species has been recorded from the Paleocene and Eocene of the U.S. Atlantic and Gulf Coasts. It is of rare occurrence in the Nerinea formation at localities PT 1 and 11.

Types: R 5313

Family UVIGERINIDAE

Genus Pseudouvigerina Cushman, 1927Pseudouvigerina muralis (Terquem)Uvigerina muralis Terquem, 1882. p.119, pl.12(20), figs.

26-29

Angulogerina muralis (Terquem), Cushman and Edwards,

1937, p.55, pl.8, figs. 3-5.

Occurrence: This species occurs in abundance in the Eocene of Paris Basin. It is of very rare occurrence in the Upper marlstones of the Nerinea formation at locality PT 20.

Types: R 5314

Pseudouvigerina seligi (Cushman)Uvigerina seligi Cushman, 1925, p.1, pl.4, fig. 1Pseudouvigerina seligi Cushman and Todd, 1943, p.65,

pl.11, fig. 19.

Occurrence: This form has been recorded only from Upper Cretaceous strata elsewhere. It is a very common form in the Upper Cretaceous of the U.S. Gulf and Atlantic Coastal Plains. In the Pondicherry area it is a very common form throughout the Nerinea formation. In the upper part of the Upper marlstones (loc. PT 19) it develops numerous faint longitudinal ribs.

Types: R 5315

Pseudouvigerina triangularis Jennings

Pseudouvigerina triangularis Jennings, 1936, p.29, pl. 3, fig. 6. Olsson, 1960, p.30, pl.4, fig. 22.

Occurrence: This species was originally described from the Paleocene of the U.S. Atlantic Coastal Plain. It occurs also in the Lower Eocene sediments. In the Pondicherry area it is of common occurrence throughout the Nerinea formation.

Types: R 5316

Pseudouvigerina wilcoxensis Cushman and Ponton

Pseudouvigerina wilcoxensis Cushman and Ponton, 1932, p.66, pl.8, fig. 18.

Angulogerina wilcoxensis (Cushman and Ponton), Cushman and Garret, 1939, p.84, pl.14, figs. 24,25. Toulmin, 1941, p.599, pl.80, fig. 30. Olsson, 1960, p.34, pl.5, fig. 12.

Occurrence: This species occurs in the Paleocene - Eocene formations of the U.S. Atlantic and Gulf Coastal Plains, Paleocene of Caucasus, Sweden etc. It occurs rarely in the Nerinea formation at localities PT 1, 2, 3, 6, 8 and 16.

Types: R 5317

Family CHILOSTOMELLIDAE

Genus Allomorphina Reuss 1850

Allomorphina halli Jennings

Allomorphina halli Jennings, 1936, p.34, pl.4, fig. 5

Brotzen, 1948, p.127, pl.19, fig.4, text-fig.

39-41. Olsson, 1960, p.41, pl.7 fig.14.

Occurrence: This is essentially a Paleocene form. It has been recorded from the Paleocene of Denmark, Sweden and the U.S. Atlantic Coastal Plain. It is of frequent occurrence in the Lower marlstones and the Algal limestones of the Nerinea formation at localities PT 2, 3, and 6. It is rare in the Discocyclusina limestones and the Upper marlstones at localities PT 7,8,13, and 18.

Types: R 5318

Family NONIONIDAE

Genus Pullenia Parker and Jones 1862Pullenia quinqueloba (Reuss)Nonionella quinqueloba Reuss, 1851, p.71, pl.5, fig.31.Pullenia quinqueloba (Reuss), Plummer, 1926, p.136, pl.

8, fig.12. Le Roy, 1953, p.45, pl.11, figs.10-11.

Occurrence: This species has been recorded from the Paleocene of the U.S. Gulf Coast, Egypt and in the Tertiary of Europe. This form occurs rarely in the Lower marlstones and the Upper marlstones of the Nerinea formation at localities PT 3 and 13.

Types: R 5319

Family ELLIPSOIDINIDAE

Genus Ellipsonodosaria Silvestri 1900

Ellipsonodosaria cocoaensis Cushman

Nodosaria cocoaensis Cushman, 1925, p.66, pl10, figs.

5,6.

Ellipsonodosaria cocoaensis Cushman, 1939, p.68, pl.11,

figs. 27-33.

Stilostomella cocoaensis (Cushman), Hofker, 1956, p.905,

text-fig.18

Occurrence: This species has been recorded from the Upper Eocene of the North American Gulf Coastal Plain and Coastal Ecuador. It occurs commonly almost throughout the Nerinea formation.

Types: R 5320

Ellipsonodosaria midwayensis Cushman and Todd

Ellipsonodosaria midwayensis Cushman and Todd, 1946,

p.61, pl.10, fig. 25.

Occurrence: This species has been recorded from the U.S. Gulf Coast where it is a guide fossil of the Paleocene. In the Pondicherry area it occurs rarely in the Upper marlstones of the Nerinea formation at localities PT 13 and 14.

Types: R 5321

Ellipsonodosaria plummerae Cushman

Nodosaria sagrinensis Bagg, Plummer, 1927 (not Bagg),

p.85, pl.4, figs.1-6

Ellipsonodosaria plummerae Cushman, 1940, p.69, pl.12,

figs.4,5. Olsson, 1960, p.35, pl.5, fig.20.

Stilostomella plummerae (Cushman), Hillebrandt, 1962,

p.86, pl.6, fig. 13.

Occurrence: This form has been recorded from the Paleocene of North America and Germany. It is present in the Lower marlstones, Algal limestones and the Upper marlstones of the Nerinea formation at almost all localities.

Types: R 5322

Family ROTALIIDAE

Genus Alabamina Toulmin 1941

Alabamina midwayensis Brotzen

Alabamina midwayensis Brotzen 1948, p.99, pl.16, figs.

1,2; text-figs.25,26.

Occurrence: This species has been recorded from the Paleocene of Denmark and Sweden, Paleocene - Eocene of North America and the Lower Eocene of Trinidad. It occurs commonly throughout the Nerinea formation.

Types: R 5323

Genus Coleites Plummer 1934

Coleites reticulosus (Plummer)

Pulvinulina reticulosa Plummer, 1927, p.152, pl.12, fig.5.

Coleites reticulosus Plummer, 1934, p.606, pl.24, figs.

5-9. Oushman, 1951, p.54, pl.15, figs.1-5.

Occurrence: This species occurs in the Paleocene and Eocene of the North American Gulf and Atlantic Coastal Plains. A few specimens of this species are found in the Discocyclina limestones and the Upper marlstones of the Nerinea formation at localities PT 7,9 and 14.

Types: R 5324

Genus Epistominella Husezima and Maruhasi 1944

Epistominella minuta (Olsson)

Pseudoparrella minuta Olsson, 1960, p.40, pl.6, figs.7-9.

Olsson described this species from the Paleocene - Eocene formations (Hornestown and Vincentown) of the New Jersey Coastal Plain. In the Pondicherry area it is present in the Valudavur formation at localities PK 6 and in the Lower marlstones of the Nerinea formation at locality PT 1.

Types: R 5325

Genus Eponides Montfort 1808

Eponides dorfi Toulmin

Eponides dorfi Toulmin, 1941, p.601, pl.81, figs.8,9.

Toulmin described this species from the Salt Mountain limestone of Alabama U.S.A. A few specimens of this form are present in the Nerinea formation at the following localities: PT 3,7,9,11,15.

Types: R 5326

Eponides cf. E. lunatus Brotzen

Eponides lunata Brotzen 1948, p.77, pl.10, figs.17,18.

Remarks: The Pondicherry form resembles Eponides lunatus Brotzen in its crescent shaped sutures but the spiral side is more convex and the umbilical side is only slightly convex; periphery subacute, nonlobate; wall coarsely perforated. Perhaps this form may be within the limits of variation recognised for E. lunatus Brotzen.

Occurrence: This species occurs in the Paleocene of Sweden, Egypt and the U.S. Atlantic Coastal Plain. It occurs in the Lower marlstones and the Algal limestones of the Nerinea formation at localities PT 3 (sample B) and PT 6.

Types: R 5327

Eponides plummerae Cushman

Eponides plummerae Cushman 1948, p.44, pl.8, fig. 9.

Occurrence: This species has been recorded from the Paleocene of the U.S. Gulf and Atlantic Coastal Plains. Typical specimens of this form are present in the Lower marlstones and the Algal limestones of the Nerinea formation at localities PT 2, 3 (sample B) and 6.

Types: R 5328

Eponides toulmini Brotzen

Eponides toulmini Brotzen 1948, p.78, pl.10, fig. 16

Occurrence: This form occurs in the Paleocene of Sweden and the U.S. Gulf Coastal Plain. It is sparsely distributed in the Lower marlstones, Algal limestones and the Discocyclina limestones of the Nerinea formation at localities PT 2,6,7 and 9.

Types: R 5329

Genus Gyroidinoides Brotzen 1942

Gyroidinoides octocamerata (Cushman and Hanna)

Gyroidina soldanii var. octocamerata Cushman and Hanna,
1927, p.223, pl.14, figs. 16-18. Brotzen, 1948,
p.76, pl.11, fig.3.

Occurrence: This species is common in the Paleocene and Eocene of the North American Gulf and Atlantic Coastal Plains. It has been recorded in the Paleocene of Sweden. This form occurs frequently in all the fossiliferous localities of the Pondicherry area.

Types: R 5330

Gyroidinoides subangulata (Plummer)

Rotalia soldanii var. subangulata Plummer, 1927, p.154,
pl.12, fig. 1

Gyroidina subangulata (Plummer), Cushman, 1940, p.71,
pl.12, fig.7 Cushman, 1951, p.51, pl.14, figs.
14,15.

Gyroidinoides subangulata (Plummer), Olsson, 1960, P.36
pl.5, figs.24,25.

Occurrence: It is a common form in the Paleocene and Eocene of North America and Trinidad. It is present in all the Paleocene and Lower Eocene localities of Pondi-

cherry.

Types: R 5331

Genus Karrereria Rzehak 1891

Karrereria fallax Rzehak

Karrereria fallax Rzehak, 1891, p.6. Cushman and Deaderick, 1944, p.339, pl.53, figs. 23,24. Brotzen, 1948, p.115, pl.18, fig.3, text=figs. 34-37. Olsson, 1960, p.39, pl.6, figs. 7-9.

Occurrence: This species occurs in the Upper Cretaceous of the U.S. Gulf and Atlantic Coastal Plains, Upper Cretaceous of Vienna and Lower Paleocene of Sweden. In the Pondicherry area it is restricted to the Lower marlstones and the Algal limestones of the Nerinea formation and occurs at localities PT 3 (sample B), and PT 6.

Types: R 5332

Genus Osangularia Brotzen 1940

Osangularia convexa(Olsson)

Parrella convexa Olsson 1960, p.38, pl.6, figs. 13-15.

Occurrence: Olsson described this species from the Hornestown formation (Upper Paleocene) of the U.S. Atlantic Coastal Plain. This form is of common occurrence in all the Paleocene and Lower Eocene localities of Pondi-

cherry.

Types: R 5333

Family ANOMALINIDAE

Genus Anomalinoides Brotzen 1942

Anomalinoides acuta (Plummer)

Anomalina ammonoides(Reuss) var. acuta Plummer, 1927,
p.149, pl.10, fig. 2.

Anomalina acuta Toulmin, 1941, p.608, pl.82, figs.9,10.

Anomalinoides acuta (Plummer), Brotzen 1948, p.87, pl.
14, fig.2. Olsson, 1960, p.51, pl.11, figs.4,5.

Occurrence: This form is present in the Paleocene and Lower Eocene of North America, Trinidad and Paleocene of Sweden. It occurs frequently in the Lower marlstones and the Algal limestones of the Nerinea formation at all localities.

Types: R 5334

Anomalinoides longi (McLean)

Anomalina longi McLean 1952, p.11, pl.2, figs.9-12.

Anomalinoides longi (McLean), Olsson, 1960, p.51, pl.11,
figs.12-14.

Occurrence: This species has been recorded from the Paleocene and Lower Eocene of the U.S. Atlantic Coastal

Plain. In the Pondicherry area it is sparsely distributed in the Nerinea formation at the following localities: PT 2,6,8,11,13,15 and 16. It is absent in the upper portion of the Upper marlstones.

Types: R 5335

Anomalinoides navarroensis Plummer

Anomalinoides navarroensis Plummer, 1927, p.150, pl.II, fig. 6

This species has been recorded from the Maestrichtian of the U.S. Gulf Coast. It is common in the Valudavur and Trigonarca formations at all localities.

Types: R 5336

Anomalinoides umbonifera (Schwager)

Discorbis umbonifera Schwager, 1883, p.126, p.27, fig.14.
Anomalina umbonifera (Schwager), Cushman and Ponton, 1932, p.72 pl.9, fig.11.

Occurrence: This species was described from the Middle Eocene of N.Africa. It has been recorded from the Paleocene and Lower Eocene of North America. This is a common form in the Nerinea formation at all localities, it is particularly abundant in locality PT 19.

Types: R 5337

Genus Cibicides Montfort 1808

Cibicides compressa Olsson

Cibicides compressa Olsson, 1960, p.53, pl.12, figs.13-15.

Occurrence: Olsson described this species from the Paleocene and Lower Eocene of the U.S. Atlantic Coastal Plain. It is present in the Discocyclina limestones and the Upper marlstones of the Nerinea formation at the following localities: PT 8, 11, 14 and 15.

Types: R 5338

Cibicides ekblomi Brotzen

Cibicides ekblomi Brotzen, 1948, p.82, pl.13, fig. 2

Occurrence: Brotzen described this form from the Paleocene of Sweden. This species occurs commonly throughout the Nerinea formation except in the upper part of the Upper marlstones.

Types: R 5339

Cibicides irenae Van Bellen

Cibicides irenae Van Bellen, 1946, p.82, pl.12, figs. 19-21.

Cibicides praecursorius (Schwager). Cushman, 1951 (not Schwager) p.65, pl.19, fig. 1.

Occurrence: This species occurs in the Paleocene and Lower Eocene of the U.S. Gulf and Atlantic Coastal Plains. It is a common form occurring in the Discocyclina limestones and the Upper marlstones of the Nerinea formation at all localities. It is particularly abundant at locality PT 13.

Types: R 5340

Cibicides megaloperforatus Said and Kenawy

Cibicides megaloperforatus Said and Kenawy, 1956, p.155, pl.7, fig.13.

Occurrence: This species was originally described from the Paleocene of Egypt. Typical specimens of this form are found in the Nerinea formation at the following localities: PT 3, 11 and 15.

Types: R 5341

Cibicides neelyi Jennings

Cibicides neelyi Jennings, 1936, p.39, pl.5, fig.4
Olsson, 1960, p.53, pl.11, figs. 15-17.

Occurrence: Jennings originally described this species from the Hornestown formation (Paleocene) of the U.S. Atlantic Coastal Plain. It occurs also in other Paleocene deposits of the Gulf and Atlantic Coastal

Plains. In the Pondicherry area this form is present in the Lower marlstones of the Nerinea formation at localities PT 3.

Types: R 5342

Cibicides howelli Toulmin

Cibicides howelli Toulmin, 1941, p.609, pl.82, figs.16-18.

Occurrence: Toulmin described this form from the Salt Mountain limestone of Alabama U.S.A (Lower Eocene). It has also been recorded from other Lower Eocene formations of the U.S. Gulf and Atlantic Coastal Plains. In the Pondicherry area it occurs in the Algal limestones and the Discocyclina limestones of the Nerinea formation at localities PT 6 to 9. Forms very close to this species occur in the Upper part of the Upper marlstones.

Types: R 5343

Cibicides blanpiedi Toulmin

Cibicides blanpiedi Toulmin, 1941, p.609, pl.82, figs. 11-13.

Occurrence: This form is abundant in the Lower Eocene of Alabama U.S.A. It is present in the Upper marlstones at locality PT 14. Specimens which could be doubtfully assigned to this species occur in the Discocyclina

limestones at localities PT 7, 8 and 9.

Types: R 5344

Cibicides succedens Brotzen

Cibicides succedens Brotzen, 1948, p.80, pl.12, figs.

1,2. text-fig. 21. Olsson, 1960, p.53, pl.12,
figs. 10-12.

Occurrence: This species was described from the Paleocene of Sweden. Olsson records it from the Hornestown formation (Paleocene) of the U.S. Atlantic Coastal Plain. It occurs commonly throughout the Nerinea formation at all localities. Forms close to this species occur in the Trigonarca formation.

Types: R 5345

Genus Cibicidoides Brotzen 1936

Cibicidoides proprius Brotzen

Cibicidoides proprius Brotzen, 1948, p. 78, pl.12, figs.

3. and 4.

Occurrence: It is one of the most frequent species in the Paleocene of N.W. Europe. Typical specimens of this species are present in the Lower marlstones, Discocyclina limestones and the Upper marlstones of the Nerinea formation at all localities.

Types: R 5346

Family CERATOBULIMINIDAE

Genus Lamarckina Berthelin 1881

Lamarckina cf L. rugulosa Plummer

Lamarckina rugulosa Plummer 1926, p.8, pl.3, fig.6.

Plummer, 1927, p.140, pl.9, fig. 3. Cushman,
1951, p.49, pl.13,fig. 24. Olsson, 1960, p.37,
pl.6, figs. 5,6.

Occurrence: This species has been recorded from the
Upper Cretaceous and Paleocene of North America. A few
specimens very close to this species are present in the
Upper marlstones of the Nerinea formation at locality
PT 16.

Types: R 5347

APPENDIX (Selected localities)

(PK and PT numbers refer to localities

57 P/12, 57 P/16 etc. refer to topo-sheet numbers)

PK 1 (57 P/12) Well section 7/8 mile due North of Vanur
at the junction of two rivulets.

<u>Formation</u>	<u>Lithology</u>	<u>Thickness</u>
Valudavur	Pale yellowish green, medium grained slightly calcareous, argillaceous, feldspathic, quartz sandstone; unfossiliferous.	18 ft.

PK 2 (57 P/16) Well section North of Andipalaiyam,
100 feet west of the northern edge of lake
bund on the western side of the cart track.

Valudavur	Pale yellowish medium to coarse grained angular, friable to compact, non calcareous, argillaceous, feldspathic, quartz sandstone with interbedded lenses of hard, compact coarse conglomeratic sandstones, bouldery in nature and composed of rounded and subrounded pebbles of quartz, orthoclase and concentrates of garnet grains showing a definite mineral lineation. Matrix made up of	
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finer grained quartz, felspar and some 20 ft.
hornblende.

Sample A (sandstone) from 2 ft.

Sample B (conglomerate) from 10 ft.

PK 3 (57 P/16) Well section 1/8 mile due North of
Rayavottai and 1/8 mile due East of the small
pond.

<u>Formation</u>	<u>Lithology</u>	<u>Thickness</u>
Valudavur	Pale yellowish brown and grey, fine grained sandy claystone mixed with kunkary material; unfossiliferous. Angular grains of quartz, felspar, and mica under the microscope.	15 ft.

PK 4 (57 P/16) Well section 1/8 mile N.W. of
Abhirampattu temple.

Valudavur	Yellowish fine grained argillaceous, calcareous sandstone containing angu- lar grains of quartz, felspar and mica, mixed with chunks of white concretion- ary material; unfossiliferous.	15 ft.
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PK 5 (57 P/12) Tank excavation 3/8 mile NNE of Ottai;
150 feet S 50° E of the temple on Ottai -
Vanur cart track.

<u>Formation</u>	<u>Lithology</u>	<u>Thickness</u>
Valudavur	Surface outcrop of grey, hard, compact, highly indurated, very fine-grained, calcareous sandstone, often with dendritic manganese coatings. Weathered surfaces appear brown; unfossiliferous.	2 ft.
	Yellowish fine grained less compact mildly calcareous, argillaceous sandstones containing angular grains of quartz, feldspar and mica. Clay and silt fraction 51%. unfossiliferous.	2 ft.
PK 6 (57 P/12) Well section 150 feet SW of PK 5 on the eastern side of Vanur - Ottai cart track.		
Valudavur	Compact fine grained sandy mudstone containing angular or subangular grains of quartz, hornblende and mica. Foraminifera common. Ostracoda rare. Sample A from 3 ft.	9 ft.
	Hard compact fine grained calcareous quartz sandstone. Foraminifera rare, poorly preserved. Base not exposed. Sample B from a depth of 10 ft.	1 ft.

PK 7 (57 P/12) Well section 1/8 mile South of 96th
milestone on Pondicherry-Vanur Road.

<u>Formation</u>	<u>Lithology</u>	<u>Thickness</u>
Valudavur	Pale yellow friable nodular fine grained calcareous quartz sandstone admixed with kunkary material; grains angular or sub-angular. Foraminifera common, Ostracoda rare.	20 ft.

PK 8 (58 M/9) Canal section 1/8 mile North of Mettuvelli.

Trigonarca	Brown indurated calcareous fine grained sandstone containing molluscan shells. Quartz, felspar, rock and shell fragments under the microscope.	1 ft.
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PK 9 (58 M/9) 3/8 mile due North of the northern edge of Tuttippattu, surface outcrop.

Trigonarca	Brown indurated calcareous, fine to medium grained quartz sandstone with molluscan shells - commonly <u>Ostrea</u> . Quartz, felspar, rock and shell fragments under microscope.	1 ft.
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PK 10 (57 P/16) Well section 1/4 mile NE of Abhirampattu temple.

Valudavur?	Yellowish white fine grained less compact, argillaceous, non calcareous, felspathic,	
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quartz sandstone. Sample A 10 ft.

Trigonarca White fine grained highly calcareous sandstone containing molluscan shells - commonly Ostrea. 2 ft.

PT 1 (57 P/16) Well section 200 yards towards NE of the northeastern edge of Papanchavadi.

<u>Formation</u>	<u>Lithology</u>	<u>Thickness</u>
Nerinea	Lower marlstones: Friable fine to medium grained calcareous argillaceous quartz sandstone composed of angular grains of quartz and glauconite. Foraminifera common.	6 ft.
Trigonarca	Shell bearing calcareous sandstone	2 ft.

PT 2 (58 M/9) 250 yards of Mettuveli in the canal section, turning point of canal in NNE direction towards Mettuveli.

Nerinea	Lower marlstones: Yellowish brown compact sandy marlstone with casts of solitary corals; medium to coarse angular grains of quartz, glauconite and limonite under microscope. Foraminifera abundant.	6 ft.
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PT 3 (57 P/16) Well section SSE of Papanchavadi, 1/8 mile west of Culvert on Pondicherry - Tindivanam road.

<u>Formation</u>	<u>Lithology</u>	<u>Thickness</u>
Nerinea	Algal limestone: Pale white, hard, compact limestone beds. Thin section shows abundant encrusting coralline algae. Foraminifera present. Ostracoda rare. Sample A from 20 ft.	30ft.
	Lower marlstones: Pale yellow marlstones; Foraminifera and algal filaments abundant; Ostracoda rare. Base not exposed. Sample B from a depth of 35 ft.	5 ft.
PT 4 (57 P/16) Quarries at the end of the channel section East of Rayapuduppakkam.		
Nerinea	Algal limestone: Hard massive, compact, white algal limestone beds. No <u>Discocyclina</u> present. Thin sections show abundant algae.	1 ft.
PT 5 (58 M/13) $\frac{1}{2}$ mile NE of Sedarappattu temple, on the eastern side of road from Sedarappattu to Tindivanam road; limestone quarries.		
Nerinea	Algal limestone: Hard compact pale brown algal limestone beds; no <u>Discocyclina</u> present; same as at PT 4.	2 ft.
PT 6 (57 P/16) Well section at the SW corner of		

Ravuthankuppam, 1/8 mile South of the temple. 30ft.

Nerinea Discocyclina limestone: Brown, hard,
compact limestone with Discocyclina;
smaller foraminifera present.
Sample A from 2 ft.

Nerinea Algal limestone: White, hard, compact algal
limestone; smaller foraminifera present,
no Discocyclina. Sample B from 30 ft.

PT 7 (57 P/16) Well section 5/8 mile from the road bifur-
cation of Pondicherry-Tindivanam road, on the
West side of road.

Nerinea Discocyclina limestone: Weathered, brown,
Discocyclina bearing, hard, compact limestone.
Smaller foraminifera present. Sample from
surface; bottom inaccessible. 15 ft.

PT 8 (57 P/16) 150 feet South of SE edge of Ravuthan-
kuppam; surface outcrop.

Nerinea Discocyclina limestone: Brown, hard, compact
limestone containing Discocyclina. Smaller
foraminifera present. 2 ft.

PT 9 (57 P/16) Well section 300 yards South of SE edge
of Ravuthankuppam.

Nerinea Discocyclina limestone: Brown, hard, compact

Discocyclina bearing limestone; smaller foraminifera present. Base not exposed. 15 ft.
Sample from 2 ft.

PT 10 (58 M/9) Well section 1/8 mile East of Kondi-
medu. 30 ft.

Nerinea Discocyclina limestone: Weathered yellowish brown, hard, compact Disco-
cyclina bearing limestone. Base not accessible. Sample from 15 ft.

PT 11 (58 M/13) Channel bed 1/2 mile East of Sedarap-
pattu temple, 200 feet west of the sluice gate.

Nerinea Discocyclina limestone: Weathered, brown, hard, compact, limestone containing Disco-
cyclina. Thin sections show presence of algae. Smaller foraminifera common. 2 ft.

PT 12 (58 M/9) Canal section 1 1/4 mile SE of Valudavur
1/8 mile north of temple on road.

Nerinea Discocyclina limestone: Indurated brown limestone. Thin sections show Discocyclina and algae; smaller foraminifera very rare 5 ft.

PT 13 (58 M/13) Channel bed 5/8 mile East of Sedarappattu temple, 5 feet West of the sluice gate; surface outcrop.

Nerinea Upper marlstones: Yellowish brown, friable
marlstone; abundant smaller foraminifera
and Discocyclina. 2 ft.

PT 14 (57 P/16) Well section in the rice mill compound
7/8 mile ENE of Jagirampettai, 1/8 mile
SSE of Pettai temple.

Nerinea Upper marlstones: Yellow brown, friable
marlstone; smaller foraminifera abundant,
Discocyclina common. Base not seen. 25 ft.

PT 15 (58 M/13) 100 feet South of 97/5 milestone on
Pondicherry - Madras road, 3/4 mile West of
road bifurcation. Surface exposure. 2 ft.

Nerinea Upper marlstones: Yellowish brown friable
marlstone. Abundant smaller foraminifera
and Discocyclina.

PT 16 (58 M/13) Well section 7/8 mile SW of the road
bifurcation on Pondicherry - Madras road,
3/4 mile NW of Tiruchchittambalam temple.

Nerinea Upper marlstones: Yellowish brown, friable
marlstone; smaller foraminifera abundant;
Discocyclina common. Base not seen. 15 ft.

PT 17 (57 P/16) Well section 3/4 mile due East of
Jagirampettai, 1/4 mile SE of Pettai temple.

Nerinea Upper marlstones: Yellowish, soft, friable,
marlstone; abundant smaller foraminifera;
no Discocyclina. 30 ft.

PT 18 (58 M/13) Well section 5/8 mile NW of Tiruch-
chittambalam temple; 3/4 mile WSW of Pondi-
cherry - Madras road bifurcation.

Nerinea Upper marlstones: Pale yellow, soft,
slightly calcareous, friable marlstone;
abundant smaller foraminifera; no Dis-
cocyclina. 20 ft.

PT 19 (58 M/13) Well section 3/8 mile NW of Tiruch-
chittambalam temple; 5/8 mile SW of the bi-
furcation of Pondicherry - Madras road.

Nerinea Upper marlstones: Pale yellow, soft, fine
grained slightly calcareous, friable
marlstone; abundant smaller foraminifera;
benthonic foraminifera much restricted;
Discocyclina absent 23 ft.

PT 20 (58 M/13) Well section 100 yards South of the
Pondicherry - Madras road bifurcation.

? Yellowish brown, friable, fine to medium
grained non calcareous, argillaceous quartz
sandstone; grains subangular; mostly

- unfossiliferous, casts of Discocyclina microscopic gastropods and some Quinqueloculina are present. 20 ft.
- Nerinea Upper marlstones: Yellowish brown, friable marlstone; smaller foraminifera abundant, Discocyclina present but not common. 5 ft.
Base not exposed. Sample from 25 ft.
- PT 21 (58 M/13) Well section 1/8 mile N 10°W of Tiruchchittambalam temple at the southern end of the lake. 13 ft.
- ? Same material as at top 20 ft. in PT 20. Base not exposed.
- PT 22 (57 P/16) Surface exposures at Kottakkarai 4 ft.
- ? Same material as at top 20 ft. in PT 20.
- PT 23 (57 P/16) 1/2 mile East of the southern edge of Pudur, at the eastern boundary of lake.
- ? Same material as above. 20 ft.

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PLATE I

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Fig. 9. <u>Heterohelix globulosa</u> (Ehrenberg). Hypotype (R 5201). From the Valudavur formation (PK 7) x 210	69
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- Figs. 14, 15. Rugoglobigerina pustulata Bronnimann Hypotype (R 5227) 14, Spiral view, 15, edge view. From the Valudavur formation (PK 7). x 210 90
- Fig. 16. Guembelitria cretacea Cushman. Hypotype (R 5207). From the Valudavur formation (PK 6A) x 325 74
- Fig. 17. Pseudotextularia elegans (Rzehak), Hypotype (USNM 641354). From the Valudavur formation (PK 7). x 100 74
- Figs. 18, 19. Globotruncana fornicata, Plummer. Hypotype (R 5218). 18, Spiral view, 19, Edge view From the Valudavur formation (PK 6B). x 145 83
- Fig. 20. Pseudoguembelina excolata (Cushman) Hypotype (R 5206). From the Valudavur formation (PK 6A). x 145 73

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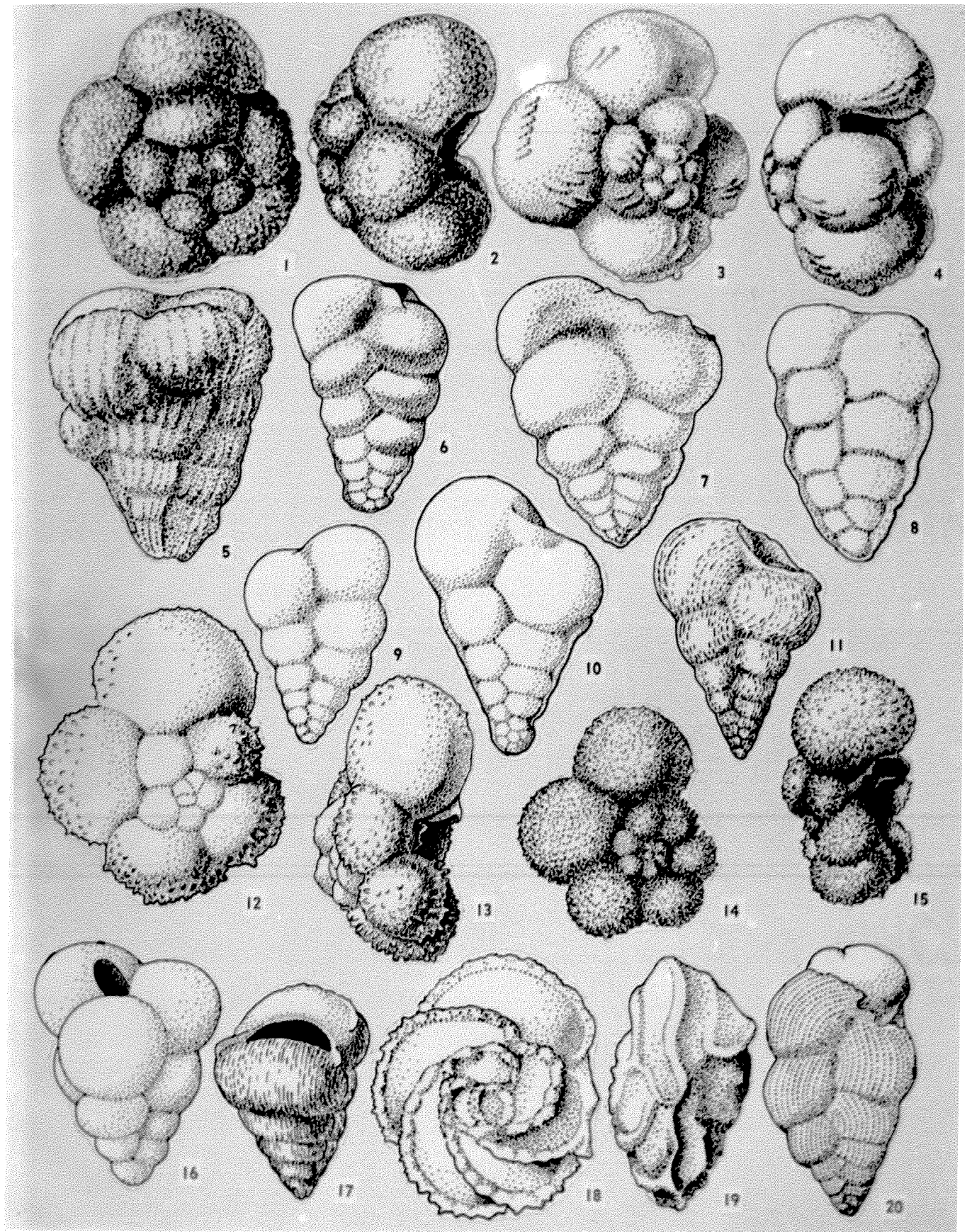


PLATE II

Figs. 1,2,3. Globotruncana stuarti stuartiformis Dalbiez
Hypotype (USNM 641360). 1 Spiral view, 2 Edge view,
3 umbilical view. From the Valudavur formation.
(PK 7). x 100 87

Figs. 4,5. Globotruncana gansseri Bolli. Hypotype
(USNM 641359). 4 Spiral view, 5 Edge view. From
the Valudavur formation (PK 6A). x 145 84

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limbate sutures. 7 Edge view showing the convex
spiral side. From the Valudavur formation (PK 7)
x 100 81

Figs. 8,9. Globotruncana gagnebini Tilev. Hypotype
(R 5219). 8, Spiral view, 9, Edge view showing the
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From the Valudavur formation (PK 6A). x 145 84

Figs. 10,11. Globotruncana contusa (Cushman)
Hypotype (USNM 641358). 10, Spiral view showing
few chambers per whorl; 11, Edge view showing the
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side and beaded spiral sutures. From the Valuda-
vur formation (PK 6A). x 145 82

Fig. 12. Planomalina messinae (Bronnimann). Hypotype
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and the equatorial aperture. From the Valudavur
formation (PK 7). x 210

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Figs. 13,14. Globorotalia pseudobulloides (Plummer)
Hypotype (USNM 641366). 13, Spiral view showing
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14, Edge view showing the extraumbilical aper-
ture with lip. From the Nerinea formation
(PT 1). x 210

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Figs. 15,16. Globorotalia trinidadensis Bolli
Hypotype (USNM 641371). 15, Spiral view showing
the greater number of chambers in the final
whorl than Globorotalia pseudobulloides and
their gradual increase in size; 16, Edge view
From the Nerinea formation (PT 1). x 210

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Plate II

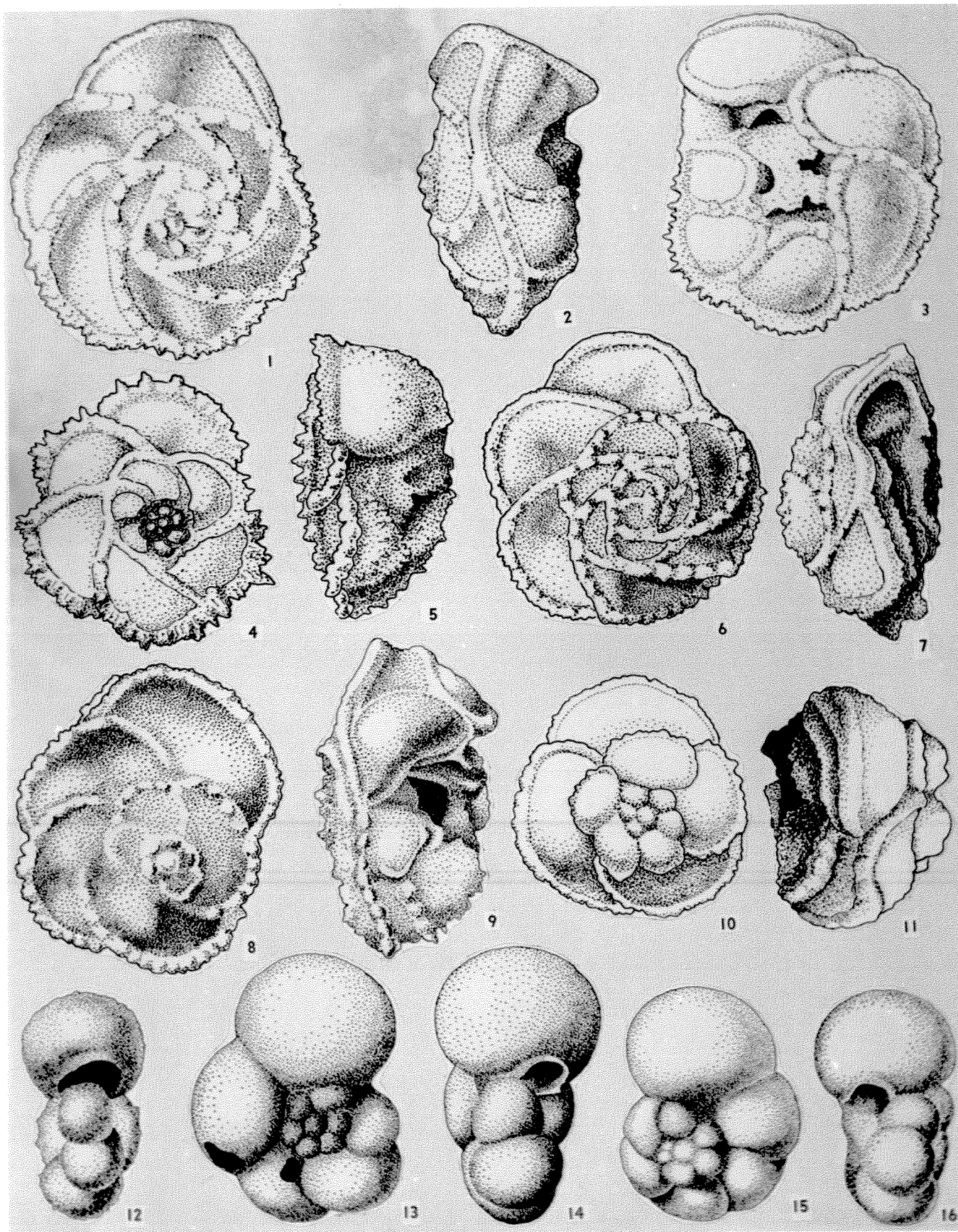


PLATE III

- Figs. 1,2,3. Globorotalia pseudoscitula Glaessner
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- Figs. 4,5. Globorotalia ehrenbergi Bolli. Hypotype (R 5248). 4, Spiral view; 5, Edge view showing the compressed test. From the Nerinea formation (PT 3B). x145 109
- Figs. 6,7,8. Globorotalia pondicherriensis Rajagopalan, n.sp. Holotype (USNM 641377). 6, Spiral view showing the rapidly enlarging chambers and radial sutures; 7, Edge view showing the inflated globular chambers and the extraumbilical umbilical aperture; 8, Umbilical view showing the small open umbilicus. From the Nerinea formation (PT 11). x 100 127
- Figs. 9,10. Globorotalia pusilla pusilla Bolli Hypotype (USNM 641369). 9, umbilical view showing the narrow open umbilicus; 10, Edge view showing the biconvex test and the acute axial periphery. From the Nerinea formation (PT 3B). x 210

- Figs. 11,12. Globorotalia formosa gracilis Bolli
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- Figs. 13,14. Globorotalia velascoensis (Cushman)
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- Figs. 15,16. Globorotalia whitei Weiss. Hypotype
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- Figs. 17,18. Globorotalia rex Martin. Hypotype
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- Fig. 19. Globigerina daubjergensis Bronnimann
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- Figs. 20,21. Globorotalia wilcoxensis Cushman and
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21, Edge view showing the planoconvex test. From
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- Figs. 22,23. Globorotalia uncinata Bolli. Hypotype
(USNM 641372). 22, Spiral view showing the

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x 145

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Plate III

