

BIOSTRATIGRAPHY OF THE ARIYALUR STAGE, CRETACEOUS OF TRICHINOPOLY*

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ABSTRACT—The Ariyalur Stage, Upper Cretaceous of Trichinopoly, South India, has yielded rich foraminifera. A biostratigraphic study of these fauna has led to the recognition of planktonic foraminiferal assemblage zones.

INTRODUCTION

Recently in India, emphasis has largely been shifted to micropalaeontology and the study of Foraminifera and Ostracoda has received a great impetus. Planktonic foraminifera have been stressed useful in stratigraphic correlation due to their wide distribution, general abundance and occurrence independent of sedimentary facies. A striking example is the well known foraminiferal genera *Globotruncana*, currently being universally recognised as a characteristic Upper Cretaceous form within which there are species with a very limited time range. According to Grimsdale (1951), the pelagic foraminifera are "ideal geological zone fossils" and it is claimed that "by means of pelagic foraminifera circumglobal correlation can be established in the Upper Cretaceous rocks".

The Ariyalur Stage, Cretaceous of Trichinopoly, has yielded rich foraminifera. In view

of the stratigraphic and palaeontological significance, a comprehensive study of the foraminiferal assemblage of the Ariyalur Stage was carried out. In the present paper, while presenting a brief account of the stratigraphy and age of the succession based on planktonic foraminiferal assemblage, an attempt to establish the biostratigraphic zones has been made.

PREVIOUS WORK

Blanford, in 1865, gave an elaborate description of the occurrence of the marine fossiliferous Cretaceous formations around Trichinopoly, Vridhachallam and Pondicherry. He classified the whole succession into three, broad groups. The Ariyalur Stage (now correctly designated) assigned to Senonian in age, was subdivided by Blanford into three on the basis of Lower and Upper having a prolific invertebrate fauna, while Middle

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TABLE I: AGE & CLASSIFICATION OF ARIYALUR STAGE, CRETACEOUS OF TRICHINOPOLY, INDIA

AGE		BLANFORD (1865)	RAMA RAO (1956)	SRIVASTAVA & TEWARI	
DANIAN	MAESTRICHTIAN	Upper	Upper	Upper	
					Lower
	SENONIAN	CAMPANIAN	Upper	Lower	Lower
					Middle
	EMSCHERIAN	Lower		Lower	
		ARIYALUR GROUP	ARIYALUR STAGE	ARIYALUR STAGE	
				Cullmood formation (Mid. Ariyalur of Blanford)	
				Kallankurichi formation	
				Sillakkudi formation	
				Lower Ariyalur of Blanford	
				Niniyur Stage (Upper Ariyalur of Blanford)	
				Niniyur Stage (Upper Ariyalur of Blanford)	

practically devoid of them. Rama Rao (1956) divided the Ariyalur Stage into lower and upper corresponding to the lower and middle groups of Blanford and assigned an age ranging from Campanian to Maestrichtian. The so-called "Upper Ariyalur group" of Blanford was designated as 'Niniyur' Stage representing Danian, on the basis of distinct faunal assemblage. During the last few decades, however, some contributions have been made by a host of workers, towards the foraminiferal assemblage of the Ariyalur beds. In the following paragraphs, however, the authors have given the result of their study conducted on the planktonic foraminiferal content of the Ariyalur beds.

LITHOLOGY

On the basis of lithological characters, the Upper Cretaceous of Ariyalur Stage can be subdivided into three stratigraphical units: Sillakkudi, Kallankurichchi and Cullmood formations. These have been named after the villages, where the outcrops are typically well exposed. The general trend of the beds of the formations is NE-SW, dipping invariably at very low angles 4° - 5° towards south-east.

Table I shows the age and classification of the Ariyalur Stage.

The Sillakkudi Formation consists chiefly of argillaceous and calcareous sandstones interbedded with cream, buff coloured sandy clays. The outcrops are well exposed in *nala* sections at Sillakkudi ($11^{\circ}4' 45''$: $79^{\circ}1'$), Sadaiyakkanapasti ($11^{\circ}2' 58''$: $79^{\circ}3' 24''$) and Vyalapadi ($11^{\circ}20' 30''$: $79^{\circ}7' 30''$).

The Kallankurichchi Formation comprises yellowish-brown, soft marls and hard arenaceous limestones. Good exposures are seen at Kallankurichchi ($11^{\circ}9'$: $79^{\circ}7'$), Ottakkovil ($11^{\circ}1'$: $79^{\circ}4'$), and Chokandapuram ($11^{\circ}16'$: $79^{\circ}7'$).

The Sillakkudi and Kallankurichchi formations correspond to the 'Lower Ariyalur group' of Blanford and Rama Rao.

The Cullmood Formation corresponding to the Middle Ariyalur group of Blanford (=Upper of Rama Rao) is made up essentially of fine sands, sandy shales, clays and calcareous concretions: and are best exposed at Kalamedu or Cullmood. Table II shows correlation of the Cretaceous of Ariyalur, Vridhachallam and Pondicherry.

BIOSTRATIGRAPHY

As stated earlier, the authors carried out detailed investigations on the foraminiferal content of the Ariyalur Stage, which form the subject matter of this paper. In this study, representatives of 18 families, belonging to 48 genera and 200 species, including 24 new species and 22 new varieties were identified. In addition to these 11 species of the genus *Globotruncana* have been recognised, the study of the stratigraphic distribution of which have proved of immense value and helped in delineating the biostratigraphy and correlation of the Ariyalur Stage.

Systematic faunal descriptions of these foraminiferal species are being published elsewhere.

It is interesting to note the distributions of the various species of the genus *Globotruncana* in the proposed stratigraphical units of the Ariyalur Stage.

In Sillakkudi formation, the Planktons confined are: *Globotruncana ventricosa* White, *G. linneiana* (d'Orbigny), *G. lapparenti-bulloids* Vogler, *G. lapparenti-lapparenti* Brotzen, *G. lapparenti-tricarinata* (Quereau).

In Kallankurichchi formation, the *Globotruncana* species are represented by *G. contusa*, (Cushman), *G. cretacea* Cushman, *G. arco*

TABLE II: CORRELATION OF CRETACEOUS OF ARIYALUR, VRIDHACHALAM & PONDICHERRY

		SRIVASTAVA & TEWARI	RAJAGOPALAN (1964)	RASHEED & GOVINDAN (1966)
Age	European Stages	ARIYALUR	PONDICHERRY	VRIDHACHALAM
Tertiary	Danian	Niniyur Stage	Pondicherry formation	
UPPER CRETACEOUS	Upper Maestrichtian	Cullmood formation	Mettuvelli formation	Pallakollai formation
	Lower Maestrichtian	Kallankurichchi formation		
	Campanian	Sillakkudi formation	Valadaur formation	Patti formation

(Cushman), *G. gansseri* Bolli, *G. stuarti-stuartiformis* Dalbies, *G. fornicata* Lapparent. In addition to these some larger Foraminifera, which are confined only in this formation are: *Lepidorbitoides inornata* Rao, *L. blanfordi* Rao, *Orbitocyclina ariyalurensis* Rao and *Siderolites calcitrapoides* Lamarck.

The Cullmood formation is practically devoid of invertebrate fossils, but some dinosaurian remains are reported to have been found in them.

Thus the biostratigraphic study of the first two of the three stratigraphical units proposed

by the authors on the lithologic basis has helped in the recognition of a definite and distinct foraminiferal assemblage in successive units. On the basis of the vertical distribution of the *Globotruncana* species, substantiated by the Orbitoidal fauna, two of these have been considered as distinct biostratigraphic zones and they are :

- (i) *Globotruncana-lapparenti-tricarinata* zone,
- (ii) *G. gansseri* zone, and the cullmood formation has been referred as,

TABLE III: RELATIONSHIP OF LITHOSTRATIGRAPHY TO BIOSTRATIGRAPHY IN THE ARIYALUR STAGE, CRETACEOUS OF TRICHINOPOLY

AGE		BIOSTRATIGRAPHY				LITHOSTRATIGRAPHY
European Equivalents	Stage	Formations	Zones	Fauna		
MAESTRICHTIAN	Upper	Cullmood	Vertebrate-bearing	Dinosaurian remains, but devoid of other invertebrate fossils	Sands, sandy shales and calcareous concretions	
	Middle	Kallankurichchi	<i>Globotruncana gansseri</i>	<i>Globotruncana stuarti-stuartiformis</i> Dalbies <i>Globotruncana gansseri</i> Bolli <i>Globotruncana arca</i> (Cushman) <i>Globotruncana cretacea</i> Cushman <i>Globotruncana formicata</i> Plummer <i>Globotruncana contusa</i> (Cushman) <i>Lepidorbitoides inornata</i> Rao <i>Lepidorbitoides blanfordi</i> Rao <i>Orbitocylina ariyalurensis</i> Rao <i>Siderolites calcitrapoides</i> Lamarck	Yellowish - brown soft marl and hard arenaceous limestones	
CAMPANIAN	Lower	Sillakkudi	<i>Globotruncana-lapparenti-tricarinata</i>	<i>Globotruncana-lapparenti-lapparenti</i> (Brotzen) <i>Globotruncana-lapparenti-tricarinata</i> (Quereau) <i>Globotruncana-lapparenti-bulloids</i> Vogler <i>Globotruncana ventricosa</i> White	Argillaceous and calcareous sandstones interbedded with cream & buff coloured sandy clays	

(iii) Vertebrate-bearing zone.

Table III shows the relationship of lithostratigraphy to biostratigraphy in the Ariyalur Stage.

CORRELATION

For the correlation of the present proposed biostratigraphic zones of the Cretaceous of Ariyalur Stage with those of the well established Upper Cretaceous biostratigraphic zones, the established geological range and the distribution of the *Globotruncana* species have been considered in view of their being the best foraminiferal index fossil of the Upper Cretaceous.

(i) The *Globotruncana-lapparenti-tricarinata* zone of the Sillakkudi formation corresponds to (i) *Globotruncana-lapparenti-tricarinata* zone (G₁) of Campanian age established by Bolli, in the Upper

Cretaceous Gauyaguayare formations well as Napparinia Hill formation of Trinidad.

(ii) *Fronicularia pattiensis* zone of Campanian age of the Patti formation of Vriddhachallam (Rasheed & Govindan, 1966).

(iii) *Globotruncana-lapparenti-tricarinata* zone of Valduar formation of Pondicherry (Rajagopalan, 1964).

The *Globotruncana gansseri* zone of the Kallankurichchi formation is characterised by the widely distributed *Globotruncana* species e.g. *G. gansseri* Bolli, *G. arca* (Cushman) etc., which pinpoint, the age of this zone as Lower Maestrichtian. This is confirmed by the presence of typical Maestrichtian Orbitoidal species. This zone corresponds to *G. gansseri* (G₂) Zone of the Trinidad established by Bolli in Trinidad, (ii) Chalk beds of Farfara Oasis

TABLE IV: CORRELATION OF ARIYALUR STAGE WITH CRETACEOUS OF GULF COAST & EUROPE

Correlation with Stages of		ARIYALUR STAGE		
Gulf Coast	Europe	Formations	Zones	
Navarro	Upper	MAESTRICHTIAN	Cullmood	Vertebrate-bearing
	Lower		Kallankurichchi	<i>Globotruncana gansseri</i>
Taylor	Campanian	Sillakkudi	<i>Globotruncana-lapparenti-tricarinata</i>	

Egypt, (iii) *G. gansseri* zone of Mettuvelli formation of Pondicherry (Rajagopalan, 1964), and (iv) *G. lapp-tri* zone of Patti formation, Vridhachallam (Rasheed and Govindan, 1966).

In addition to these, both these biostratigraphic zones of Ariyalur exhibit close resemblance and identical composition of faunal assemblage to the Upper Cretaceous of American Gulf Coast area.

The Vertebrate-bearing zone of the Cullmood formation, which represents the culmination of the Ariyalur sedimentation, overlies the *G. gansseri* zone of Kallankurichchi formation of Lower Maestrichtian age and hence its age can be assigned to Upper Maestrichtian. This zone corresponds to Pallakallai formation of Vridhachallam and also Upper part of Mettuvelli formation of Pondicherry.

Table IV shows the correlation of Ariyalur Stage with Cretaceous of Gulf Coast area.

CONCLUSION

Thus the Ariyalur Stage, Upper Cretaceous of Trichinopoly can be divided on lithologic basis into three stratigraphical units, i.e., Sillakkudi, Kallankurichchi formations corresponding to the Lower Ariyalur of Blanford and Rama Rao, and Cullmood formation corresponding to the Middle Ariyalur of Blanford (=Upper of Rama Rao). Biostratigraphically the first two lithologic units are represented by *Globotruncana-lapparenti-tricarinata*, and *G. gansseri* zones and the third as Vertebrate-bearing zone, thus fixing the age of the formations to Campanian, Lower Maestrichtian and Upper Maestrichtian respectively.

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