Ostracode fauna from the Patti Formation (Late Cretaceous) of Vridhachalam area, Tamil Nadu, India

S. Sugumaran, H.M. Nagaraj & U.B. Mallikarjuna

Sugumaran S, Nagaraj HM & Mallikarjuna UB 1997. Ostracode fauna from the Patti Formation (Late Cretaceous) of Vridhachalam area, Tamil Nadu, India. *Palaeobotanist* **46** (1,2) :133-140.

An ostracode fauna is recorded from the Patti Formation (Late Cretaceous) of Vridhachalam area, Tamil Nadu. The assemblage includes *Bairdia pentagonalis, B. cretacea, B. supplanata, Macrocypris limburgensis* and *Paracypris limburgensis*, which are typical of Maestrichtian age. The ostracodes show strong affinities with those recorded from the Ariyalur and Pondicherry areas, and those described from the type-Maestrichtian of Holland. The above assemblage and the presence of distinct Paleocene ostracodes in the overlying Pondicherry Formation throw light on K/T transition in the Vridhachalam area. The paper also discusses the stratigraphic distribution and zoogeographic affinities of the ostracode fauna with equivalent formations in India and the type-areas elsewhere.

Key-words—Ostracodes, Vridhachalam area, Patti Formation, Cretaceous-Tertiary transition, Maestrichtian, India.

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सारांश

तमिलनाडु (भारत) में वृद्धाचलम् क्षेत्र के पट्टी शैल-समूह (अनंतिम क्रीटेश्यस) से ओस्ट्राकोड जीवजात

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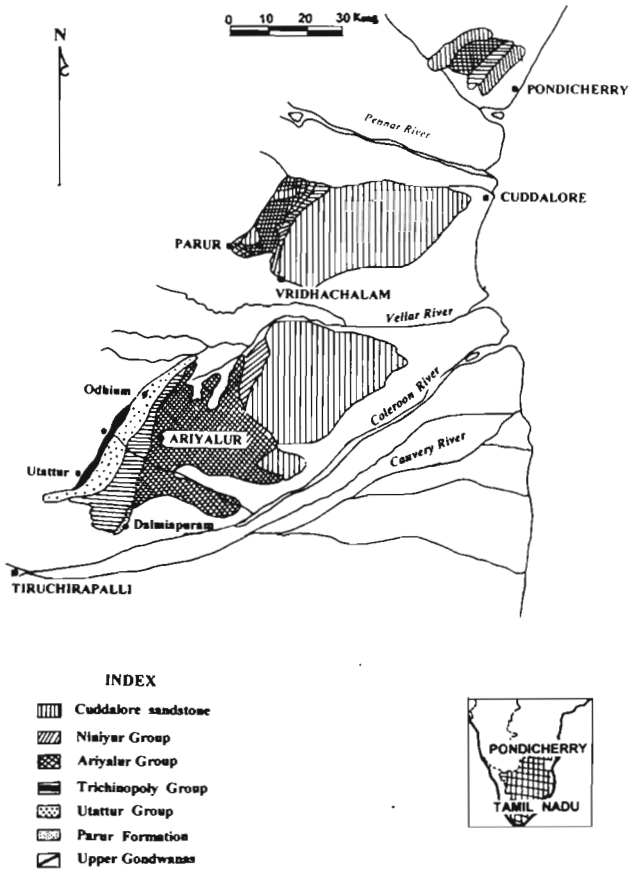
तमिलनाडु में वृद्धाचलम् क्षेत्र के पट्टी शैल-समूह (अनंतिम क्रीटेश्यस) से ओस्ट्राकोड जीवजात का वर्णन किया गया है। इस समुच्चय में *बेयर्डिआ पैंटागोनेलिस, बे. क्रीटेशिआ, बे. सप्लानाटा, मैक्रोसिप्रिस लिम्बर्जेन्सिस* एवं *पैरासिप्रिस लिम्बर्जेन्सिस* नामक वर्गक सम्मिलित हैं जो कि मॉस्ट्रिक्शियन आयु के हैं। प्राप्त ओस्ट्राकोड वर्गक अरियालूर एवं पाण्डिचेरी के विभिन्न क्षेत्रों तथा हालैंड के मास्ट्रिक्शियन आयु के हैं। प्राप्त ओस्ट्राकोड वर्गक अरियालूर एवं पाण्डिचेरी के विभिन्न क्षेत्रों तथा हालैंड के मास्ट्रिक्शियन कालीन वर्गकों से समानता प्रदर्शित करते हैं। उपर्युक्त समुच्चय तथा उपरिशायी पाण्डिचेरी शैल-समूह से प्राप्त पेलियोसीन ओस्ट्राकोडों से वृद्धाचलम् क्षेत्र में क्रीटेश्यस/टर्शियरी परिवर्तन के विषय में महत्वपूर्ण जानकारी प्रदान करते हैं। इस शोध-पत्र में ओस्ट्राकोड जीवजात के स्तरिकीय वितरण की विवेचना भारत एवं अन्य देशों के समतुल्य शैल-समूहों से भी की गई है।

THE Late Campanian-Maestrichtian sediments occur in narrow patches occupying the low country between Manimukta and Gadilum rivers (latitudes 11° 35' & 11° 45' N : longitudes 79° 15' & 79° 30' E), of Vridhachalam area. Though marine fossiliferous rocks of the area are limited in extent, their position between two disconnected larger exposures of Cretaceous in Tiruchirapalli and Pondicherry areas (Text-figure 1) makes them more interesting, both palaeontologically and stratigraphically. They are well exposed on the western margin and rest on the Archaean gneisses, and in turn are overlain by the Tertiary rocks of Paleocene-Miocene age.

The lower part of the sedimentary succession in the area comprises brownish to yellowish-grey, weathered gritty to coarse-grained sandstones of Parur Formation (= Sivaganga Formation). The Parur Formation is overlain by the Patti, Ariyalur and Palakkollai Formations in ascending order. This Mesozoic sequence is overlain by the Pondicherry Formation (Palaeocene) consisting mainly of yellowish-brown clay, weathered limestone and sandy marls. At the top of the succession rest Cuddalore Sandstone and Alluvium of Miocene to Recent age, respectively.

The Patti Formation mainly consists of indurated reddish-brown arenaceous limestone intercalated at places with marls, calcareous grits, sandstones and shales. The beds are more or less horizontal and occasionally show a gentle dip of less than 5°



Text-figure 1 — Map showing the Cretaceous-Tertiary succession in Tamil Nadu and Pondicherry.

towards east, along NE-SW trend. The name Patti Formation has been considered for the older fossiliferous series of Blanford of the Vridhachalam area with Patti Village, 10 km north-west of Vridhachalam town as its type locality (Rasheed & Govindan, 1966). The limestone is more conspicuous and rests unconformably on the Archaean rocks. Further north of Patti the beds are covered over by the sandstone patches and reappear at Pallipattu. The same beds of limestone can be traced up to Sendamangalam which forms the northern-most exposure of the Patti Formation. Lithologically, Patti Formation corresponds to the lower Ariyalur (= Sillakkudi Formation) of Tiruchirapalli area.

PREVIOUS WORK

Kaye and Cunliffe (1861, cited in unpublished Ph.D. Thesis; Govindan, 1965) made the first collection of fossils from the area. Later, Blanford (1865) gave the first elaborate account of the nature and deposition of Cretaceous rocks together with important fossil occurrences from different stratigraphic levels. The large collection of fossils made by him was later studied in detail by Stoliczka (1861-73). Govindan (1969) recorded 37 species of ostracode fauna belonging to 18 genera and 3 families, especially from the Patti, Erumanur and Mattur areas. He assigned Late Campanian to Maestrichtian age for these beds and inferred a littoral to shallow marine environment. Banerji (1970) recorded a total of 25 taxa, including 13 new species, from the Lower Ariyalur 'Stage' (Upper Turonian-Lower Maestrichtian).

MATERIAL

During 1993-95, about 50 samples were collected from the outcrops, stream sections and unlined dug wells. Best developed exposures can be seen just north of the town Vridhachalam in and around Reddikuppam Killanur, Patti and Sendamangalam. The geological map and sampling locations for the study of ostracodes are shown in the Text-figure 2. The samples have yielded well preserved ostracode fauna in addition to foraminiferal assemblage. The ostracode specimens are illustrated in Plates 1 and 2. The frequency distribution and stratigraphic range of ostracodes are shown in Tables 1 and 2, respectively.

PLATE 1

(In all cases the scale bar represents 100 μm)

1. *Cytherella ovata* (Roemer), Left valve view.
2. *Cytherelloidea* cf. *tricarinata* Sastri & Mamgain, right valve view.
3. *Bairdia* ex. gr. B. *pentagonalis* Veen, right valve view.
4. *Bairdia* ex. gr. *B. cretacea* Veen, right valve view.
5. *Bairdia supplanata* Veen, right valve view.
6. *Ovocytheridea ariyalurensis* Jain, left valve view.
7. *Veenidea limburgensis* Veen, right valve view.
8. *Cushmanidea pandei* Jain, right valve view.
9. *Neocytherideis elongata* (Sastri & Mamgain), left valve view.
10. *Neocytherideis reymenti* Jain, left valve view.
11. *Actinocythereis subelongata* Banerji, side view.
12. *Kikliocythere szczechurae* Jain, right valve view.
13. *Leguminocythereis subrectangulata* Singh & Porwal, right valve view.
14. *Leguminocythereis* sp. aff. *L. heistensis* (Keij), left valve view.
15. *Murrayina ariyalurensis* Jain, left valve view.

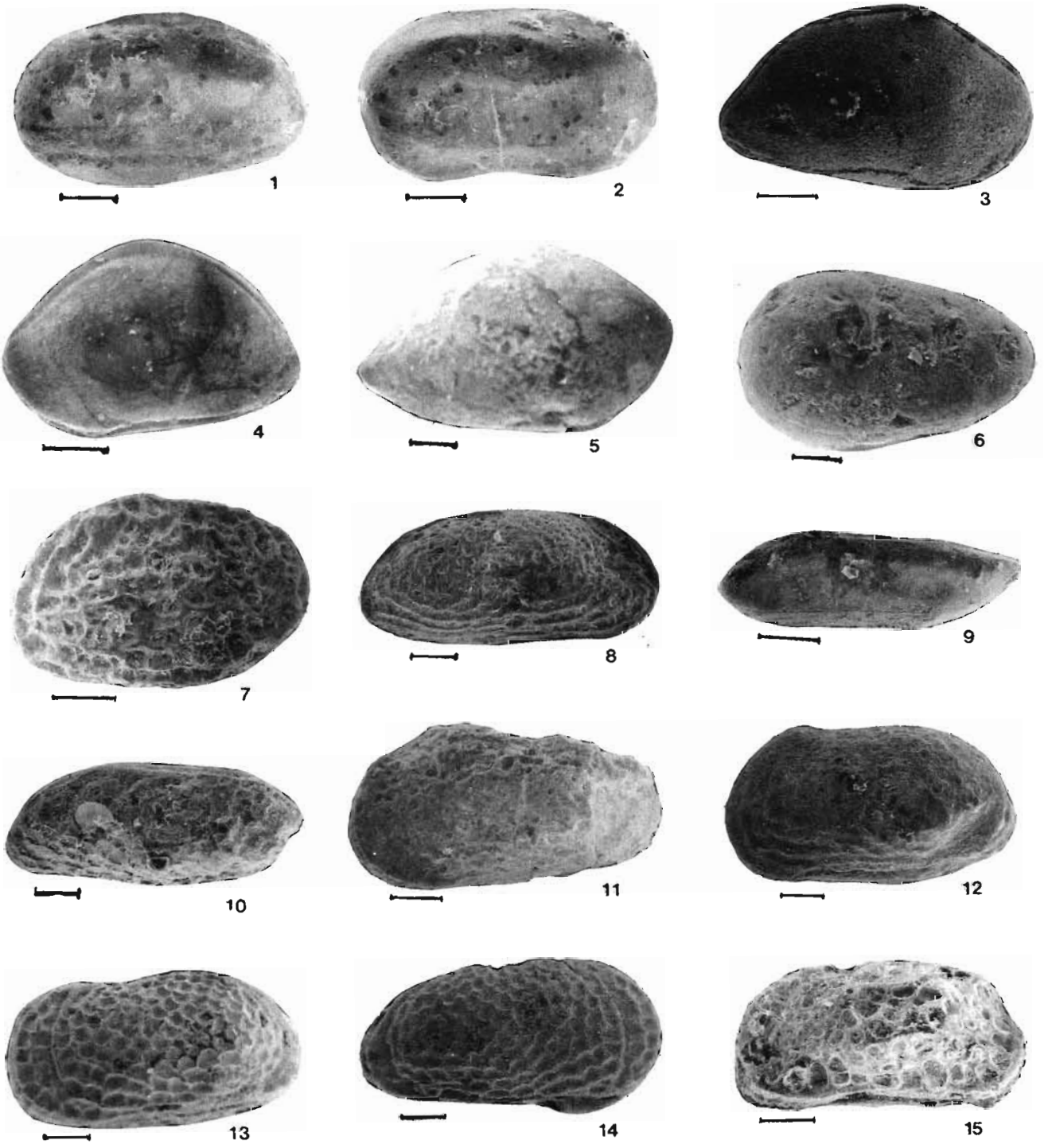
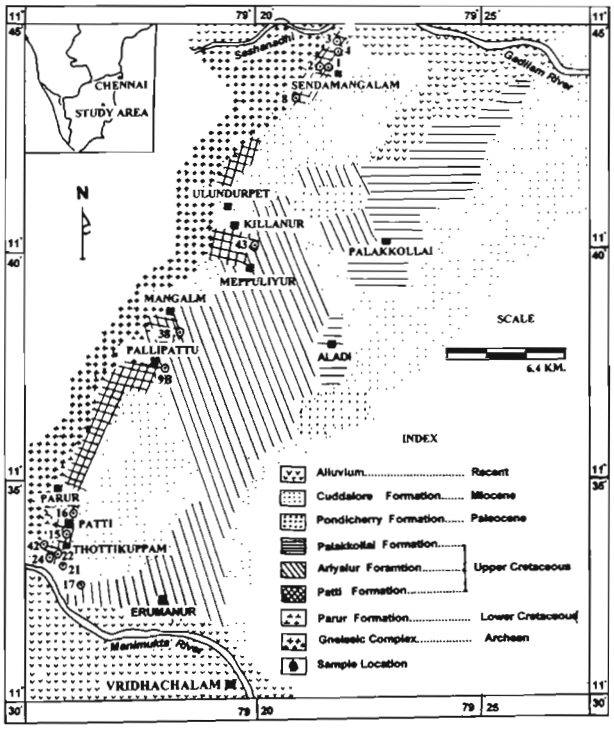


PLATE 1



Text-figure 2— Geological map of Vridhachalam area showing sample locations (modified after Venkatachala & Sharma, 1974).

The principal reasons for interest in the study of ostracodes of the area are, (i) the Upper Cretaceous ostracodes of the Ariyalur area have been studied in detail, whereas the ostracodes from the Vridhachalam area have not received much attention, (ii) the ostracodes of the region have striking resemblance with forms known from the Upper Cretaceous sediments of the Indo-Pacific biogeographic province and thus suggest a possible route of migration, and (iii) the study will aid in better understanding of the faunal relationships of adjacent areas within and outside southern India.

COMPOSITION, DISTRIBUTION AND ZOOGEOGRAPHY OF THE FAUNA

A total of 21 ostracode taxa have been recorded, of which 5 were reported by earlier workers from the Vridhachalam area. Apart from ostracodes, foraminifera, fish fragments and molluscan shells are also common. The following is the check list of ostracodes recorded in the present study.

Table 1—The frequency distribution of Ostracodes from the Patti Formation of Vridhachalam area, southern India

PATTI FORMATION															
1	2	3	4	8	9B	13	15	16	17	21	22	38	42	43	SAMPLES / SPECIES
											R				*Cytherella ovata* (Roemer)
													R	+	*Cytherelloidea* cf. *tricarinata* Sastri & Mamgain
						X		X							*Bairdia pentagonalis* Veen
								X							*Bairdia cretacea* Veen
			+										X		*Bairdia supplanata* Veen
													R		*Ovocytheridea ariyalurensis* Jain
													X		*Veenidea limburgensis* Veen
											+		R		*Cushmanidea pandei* Jain
								R				R			*Neocytherideis elongata* (Sastri & Mamgain)
								X				R			*Neocytherideis reymenti* Jain
					+		R	R		+					*Actinocythereis subelongata* Banerji
							•						•		*Kikliocythere szczechurae* Jain
					X	R							R		*Leguminocythereis subrectangulata* Pratap, Singh & Porwal
						R							R		*Leguminocythereis* sp. aff. *L. heistensis* (Keij)
									+			R			*Murrayina ariyalurensis* Jain
		X				R			+			R		X	*Xestoleberis ovata* Bonnema
X			X	+											*Macrocypris limburgensis* Veen
X	+		+							X		X			*Paracypris limburgensis* Veen
						R						R			*Krithe boldyi* Banerji
										R				+	*Schuleridea bilobata* (Triebel)
							X	X							*Loxoconcha rugialvus* Crane

+ Very rare (1)
R Rare (2-5)
X Common (6-20)
• Abundant (> 20)

Table 2—General stratigraphic range chart of Ostracode fauna of the Cretaceous-Tertiary succession of the Vridhachalam area (* Present work)

CAMPANIAN-MAESTRICHTIAN			PALAEOCENE	STAGE
PATTI	ARIYALUR	PALAKKOLLAI	PONDICHERRY	FORMATION / SPECIES
				Cytherella ovata (Roemer) *
				Cytherelloidea cf. *tricarinata* Sastri & Mamgain *
				Bairdia pentagonalis Veen *
		U		*Bairdia cretacea* Veen *
				Bairdia supplanata Veen *
		n		*Ovocytheridea ariyalurensis* Jain *
				Neocytherideis reymenti Jain *
		f		*Kikliocythere szczechurae* Jain *
				Murrayina ariyalurensis Jain *
		o		*Xestoleberis ovata* Bonnema *
				Macrocypris limburgensis Veen *
		s		*Paracypris limburgensis* Veen *
				Actinocythereis subelongata Banerji *
		s		*Cushmanidea pandei* Jain *
				Krithe boldyi Banerji *
		i		*Veenidea limburgensis* Veen *
				Leguminocythereis subrectangulata Pratap Singh & Porwal *
		l		*Leguminocythereis* sp. aff. *L. heistensis* (Keij) *
				Loxoconcha rugialvus Crane *
		i		*Schuleridea bilobata* (Triebel) *
				Neocytherideis elongata (Sastri & Mamgain) *
		f		*Bairdia ariyalurensis* Banerji
				Bairdia binkhorsti Veen
		e		*Bairdia decumana* Veen
				Bairdia crespedesensis Van den Bold
		r		*Brachycythere boldi* Pratap Singh & Porwal
				Cytherella truncata (Bosquet)
		o		*Cytherella renzi* Banerji
				Cytheropteron barrisi Skinner
		u		*Cytheropteron nealei* Jain
				Xestoleberis perjensi Veen
		s		*Pontocyprella jaini* Mallikarjuna
				Cytherella rajuii Guha & Shukla
				Cytherella fusiforma Ducasse
				Cytherelloidea bhatiai Guha & Shukla
				Cytherelloidea vridhachalamensis Guha & Shukla
				Cyamocytheridea niniyurensis Mallikarjuna
				Schizocythere levinsoni Rajagopalan
				Bairdia talukdari Guha & Shukla
				Bairdopillata poddari Lubimova *et al.*
				Cuneocythere keiji Guha & Shukla
				Phalcocythere rete Siddiqui
				Phalcocythere dissenta Siddiqui
				Phalcocythere transquilis Al Furaih
				Acanthocythereis alacer Al Furaih
				Acanthocythereis cf. *spongiosa* Al Furaih
				Costa niniyurensis Mallikarjuna
				Kingmaina sastrii Guha & Shukla
				Echinocythereis multicostata Deltel *et al.*
				Bracbycythere mckenjiei Guha & Shukla
				Hermanites scopes Siddiqui
				Xestoleberis rupnarayanalurensis Guha & Shukla
				Propontocypris (Expontocypris) kboslai Bhandari
				Occultocythereies indistincta Siddiqui
				Uroleberis gopurapuramensis Guha & Shukla
				Uroleberis reticulata Guha & Shukla
				Paracypris contracta (Jones)

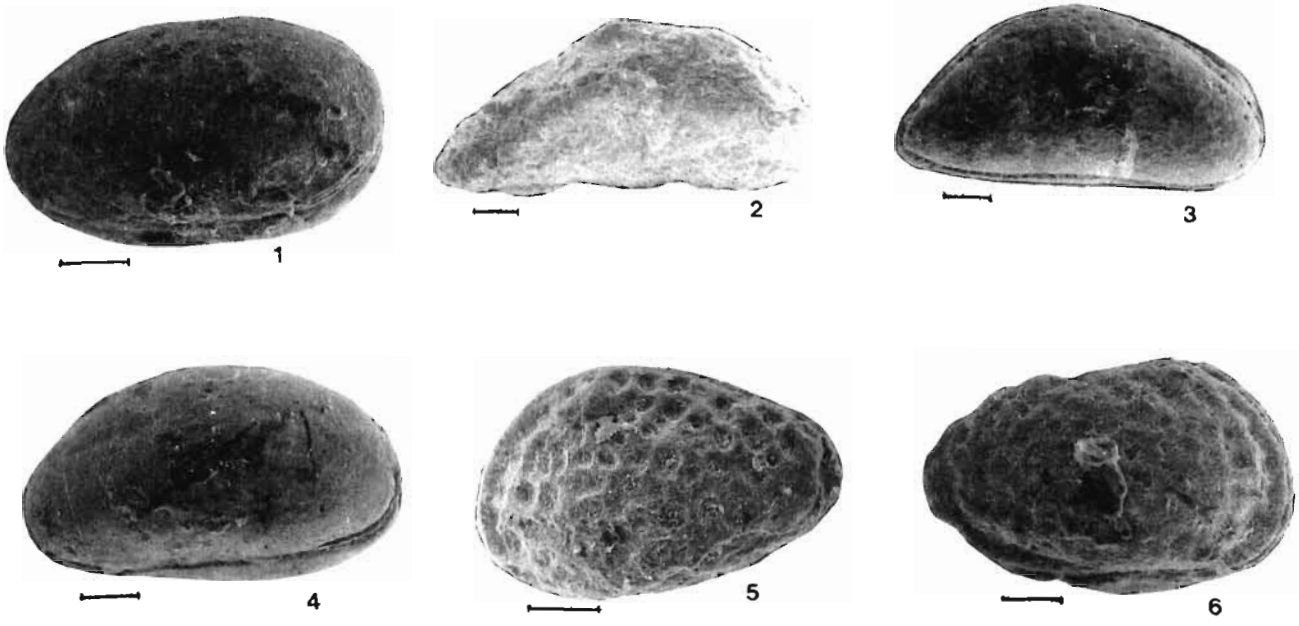


PLATE 2

(In all cases the scale bar represents 100 μm)

1. *Xestoleberis ovata* Bonnema, right valve view.
2. *Macrocypris limburgensis* Veen, right valve view.
3. *Paracypris limburgensis* Veen, right valve view.
4. *Krithe boldyi* Banerji, right valve view.
5. *Schuleridea bilobata* (Triebel) Banerji, right valve view.
6. *Loxoconcha rugialvus* Crane, right valve view.

Cytherella ovata (Roemer)
Cytherelloidea cf. *tricarinata* Sastri & Mamgain
Bairdia ex. gr. B. *pentagonalis* Veen
Bairdia ex. gr. B. *cretacea* Veen
Bairdia supplanata Veen
Ovocytheridea ariyalurensis Jain
Veenidea limburgensis Veen
Cushmanidea pandei Jain *Neocytheridets elongata* (Sastri & Mamgain)
Neocytheridets reymenti Jain
Actinocythereis subelongata Banerji
Kikliocythere szczechurae Jain
Leguminocythereis subrectangulata Singh & Porwal
Leguminocythereis sp. aff. *L. hetstensis* (Keij)
Murrayina ariyalurensis Jain
Xestoleberis ovata Bonnema
Macrocypris limburgensis Veen
Paracypris limburgensis Veen *Krithe boldyi* Banerji
Schuleridea bilobata (Triebal)
Loxoconcha rugialvus Crane

Majority of the taxa recorded are from the arenaceous limestones of Patti Formation. The species restricted to this are : *Cytherella ovata, Cytherelloidea* cf. *tricarinata, Ovocytheridea ariyalurensis, Kikliocythere szczechurae, Murrayina ariyalurensis, Xestoleberis ovata, Macrocypris limburgensis, Paracypris limburgensis* and *Loxoconcha rugialvus*. Other dominant forms in the assemblage are: *Bairdia pentagonalis, B. cretacea, B. supplanata* and *Xestoleberis ovata*. Most of the forms are endemic and a few are cosmopolitan in nature. They can be compared well with the fauna of Pondicherry and Ariyalur areas.

Kikliocythere szczechurae, Bairdia cretacea, B. pentagonalis, B. supplanata, Veenidea limburgensis, Macrocypris limburgensis and *Paracypris limburgensis* are recorded for the first time. These species are known from Sillakkudi and Kallankurchchi Formations of the Ariyalur area, and also from the type-Maestrichtian of Holland. It is obvious that some species signify the cosmopolitan character of ostracodes of Vridhachalam area. However, species

such as, *Krithe boldyi, Schuleridea bilobata* and *Loxoconcha rugialvus* are endemic in nature and restricted to the Patti Formation. It may be believed that there was a free movement of ostracode fauna between West Africa, North Africa, North America, West Europe and India during the Cretaceous times (Bhatia, 1984).

AGE IMPLICATION

The Patti Formation also records abundant and well-preserved planktic and benthic foraminifera, the presence of these being the main source of information for age determination. The occurrence of important keeled *Globotruncana* and *Rugoglobigerina* confirmed the Upper Campanian age for the Patti Formation (Govindan, 1969; Banerji, 1970). This correlates well with the *Karapaditties karapadensis* Zone of ammonites (Upper Campanian) of the Ariyalur area (Sastry *et al.*, 1968). Therefore, the sedimentation initiated during Campanian times and not in Late Santonian to Early Campanian as was believed earlier. There are nine species of ostracodes which are common with the Sillakkudi Formation of the Ariyalur area. These are *Actinocythereis subelongata, Cushmanidea pandei, Krithe boldyi, Veenidea limburgensis, Leguminocythereis subrectangulata, L. heistensis, Loxoconcha rugialvus, Schuleridea bilobata* and *Neocytherideis elongata*. The species which extend their range into the overlying Ariyalur Formation are shown in Table 2 and bear similarity with European forms of Maestrichtian age. *Cytherella ovata,* a long ranging cosmopolitan species known from the Aptian-Albian (Oertli, 1958) and Cenomanian-Maestrichtian (Babinot, 1980) of France, occurs commonly in the Patti Formation. Therefore, its indicated age range from Aptian-Upper Campanian may not be of any help in the present work to consider age aspects of arenaceous unit of the Patti Formation. *Veenidea limburgensis* which is abundant in the collection is also known from the Maestrichtian of different parts of the world. Therefore, evidences furnished by the ostracode species suggest Upper Campanian-Lower Maestrichtian age for the Patti Formation of Vridhachalam area.

CRETACEOUS-TERTIARY TRANSITION

A few continuous sections across the boundary are known from the Cauvery Basin (Raju *et al.*, 1991), besides the well known section from Meghalaya (Bhandari *et al.*, 1987). The Cretaceous sea which deposited sediments in the Tiruchirappalli area from Upper Albian onwards had its maximum extension during Campanian-Maestrichtian time covering Vridhachalam and Pondicherry. It receded at the end of Maestrichtian and before long transgressed again introducing different fauna. The Patti and Ariyalur Formations have yielded typical Campanian and Maestrichtian ostracode assemblage and comparable to the same age of Western Europe (Sugumaran, 1997). The Palakkollai Formation overlies the Ariyalur Formation and yielded no ostracodes. The contact between the Ariyalur and Palakkollai Formations are gradual. On the basis of its sequence and unfossiliferous nature the Palakkollai Formation is assigned to Late Maestrichtian (Rasheed & Govindan, 1966). The Pondicherry Formation overlies the Palakkollai Formation and yielded typical Paleocene ostracodes (Nagaraj *et al.*, 1996) which are totally different from those of Patti and Ariyalur Formations (Late Cretaceous). Therefore, it is possible to place the KTB above the Palakkollai Formation (Late Maestrichtian) and below the Pondicherry Formation (Paleocene) in Vridhachalam area.

ACKNOWLEDGEMENTS

The authors are thankful to the Chairman, Department of Geology, Bangalore University, Bangalore for his kind encouragement and facilities. SS is grateful to the Chairman, N.C.S.I. (IISc, Bangalore) for C.D. ROM Search Programme. Dr (Mrs) Neera Sahni CAS in Geology, Punjab University, Chandigarh for taking SEM photomicrographs and the Special Cell of the Bangalore University, Bangalore for the financial assistance to carry out the present investigation. UBM is thankful to DST for the financial assistance.

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