Representation of acritarchs across the Permian-Triassic Boundary in India

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The paper deals with the review of published as well as new data on acritarchs from the Late Permian and Early Triassic sediments of peninsular India. Acritarch representation in terms of form diversity and quantitative acme phase is assessed. From the present state of knowledge the Acritarcha Group shows high form diversity during latest Permian with high quantity in South Rewa and Rajmahal basins and Godavari Graben. During Early Triassic low to medium form diversity is observed in Damodar and South Rewa Gondwana basins. During late Early Triassic high form diversity and high quantity is represented in Talcher Coalfield. The record of *Micrhystridium*, *Cymatiosphaera* and *Veryhachium* in the Late Permian and *Muraticavea* in Early Triassic sediments significantly points towards transgression of sea during Late Permian and Late Early Triassic in India although no physical data is available.

Key-words—Acritarch, Palaeoenvironment, Permian-Triassic Boundary, India.

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सारांश

भारत मे परमियन-ट्रायॅसिक सीमा पर ऍक्रीटार्को की उपस्थिति

अर्चना त्रिपाठी

इस शोध-पत्र में प्रायद्वीपीय भारत के अनंतिम परमियन एवं प्रारम्भिक ट्रायॅसिक अवसादों से प्राप्त एक्रीटार्को पर प्रकाशित साहित्य एवं नये आँकड़ों की विवेचना की गई है । आकारिकीय विभिन्नता एवं परिमाणात्मक विश्लेषण के आधार पर इनका मूल्याँकन किया गया है। गोदावरी द्रोणिका तथा दक्षिण रीवा एवं राजमहल द्रोणीयों में अनंतिम परमियन काल से प्राप्त एक्रीटार्क अत्यधिक विविधता प्रदर्शित करते है । प्रारम्भिक ट्रायॅसिक काल में दामोदर एवं दक्षिण रीवा गोंड़वाना द्रोणीयों में निम्न से मध्यम प्रकार की विविधता प्रेक्षित की गई है। लेकिन तलचीर कोयला-क्षेत्र में अनंतिम-प्रारम्भिक ट्रायॅसिक काल में इनमें अधिक विविधता एवं इनकी अधिक मात्रा मिलती है । अनंतिम परमियन काल में *माइक्रोहिस्ट्रिडियम्, साइमेटोस्फेयरा* और *वेरीहाचियम* तथा प्रारम्भिक ट्रायॅसिक अवसादों में *मूरटिकेविआ* की उपस्थिति से इस काल में भारत में समुद्री अतिक्रमण इंगित होता है हालाँकि इसकी पुष्टी हेतु कोई भौतिक आँकड़े उपलब्ध नहीं है ।

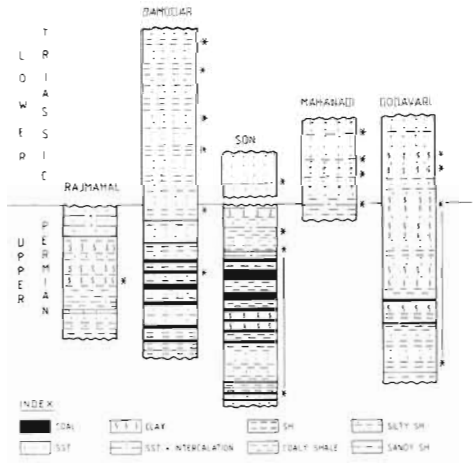
THE organic-walled planktonic fossils are referred to as the informal group Acritarcha. This group has received much attention due to its significance in palaeoenvironmental interpretation (Tappan, 1980; Traverse, 1988; Venkatachala & Tiwari, 1988). The acritarchs have been reported from the Indian Gondwana sediments, particularly in the coal deposits (Sinha, 1969; Bharadwaj & Sinha, 1969; Srivastava & Anand-Prakash, 1973; Rawat, 1984; Banerjee & D'Rojario, 1990). The data on acritarch from Permian and Triassic sequences has been synthesized (Tiwari *et al.*, 1995; Prasad *et al.*, 1995) and recently new data on acritarch has accrued from palynological studies of latest Permian and Triassic sequences of Talcher Coalfield (Tripathi, 1996). In the present communication the representation of group Acritarcha across the Permian-Triassic boundary has been discussed.

MATERIAL

The synthesis is based on the following published palynological reports :

Raniganj Coalfield, Damodar Basin—Bharadwaj & Tiwari, 1977; Bharadwaj *et al.* 1979; Tiwari & Rana, 1981, 1984; Tiwari & Singh, 1983; Singh & Tiwari, 1982.

Singrauli, Korar & Pali coalfields, Son Basin–Sinha, 1969; Bharadwaj & Sinha, 1969; Tiwari & Srivastava, 1984; Tiwari & Ram-Awatar, 1986, 1987.



Text-figure 1—Showing the representative lithocolumns from Rajmahal, Damodar, Son, Mahanadi basins and Godavari Graben considered for the present study.

Talcher Coalfield, Mahanadi Basin–Tripathi, 1996.

Rajmahal Basin–Present work.

Khamam, Chelpur, Chintalpudi, Yellendu, Manuguru, Budharam, Godavari Graben–Srivastava & Jha, 1987, 1992a, 1992b, 1993, 1995.

The lithosequences extracted from these reports are plotted in Text-figure 1 for Damodar, Son, Rajmahal and Mahanadi basins and Godavari Graben. It is observed that the acritarchs are recorded from all sorts of lithofacies—coal, shale and clay. This indicates that the presence of acritarchs is independent of lithofacies.

Analysis of data

The acritarchs are represented by the following genera.

Sphaeromorphitae
Letosphaeridia
Pilasporites
Lophospheridium
Singraulipollenites
Hindisporis
Schismatosphaeridium

Netromorphitae
Navifusa
Eupoikilofusa

Herkomorphitae
Dictyotidium
Maculatasporites
Gretnervillites
Muraticavea
Cymatiosphaera

Schizomorphitae
Hemisphaerium
Peltacystia
Circulisporites
Brazilea
Balmeella

Polygonomorphitae
Veryhachium

Tasmanititae
Tasmanites

Porata
Tetraporina
Schizosporis

Acanthomorphitae
Micrhystridium

Many of these acritarchs have been shown to have affinities with extant algae on the basis of morphological similarities of the cyst and phycoma (Tappan, 1980; Brenner & Foster, 1994; Colbath & Grenfell, 1995; Grenfell, 1995). The acritarchs recorded from the Permian and Triassic sequences of peninsular India represent following living algal groups.

Prasinophyceae

Fossil	Living
Tasmanites	*Phachysphaera*
Letosphaeridia	*Holosphaera*
Cymatiosphaera	*Pterosperma*
Dictyotidium	*Pterosperma*
Muraticavea	*Pterosperma*

Chlorophyceae

Fossil	Living
Quadrisporites horridus	*Tetrastrum punctatum*

Zygnematophyceae

Fossil	Living
Tetraporina	*Mougeotia*
Peltacystia	*Debarya*
Circulisporites	*Debarya*
Schizosporis	*Debarya*

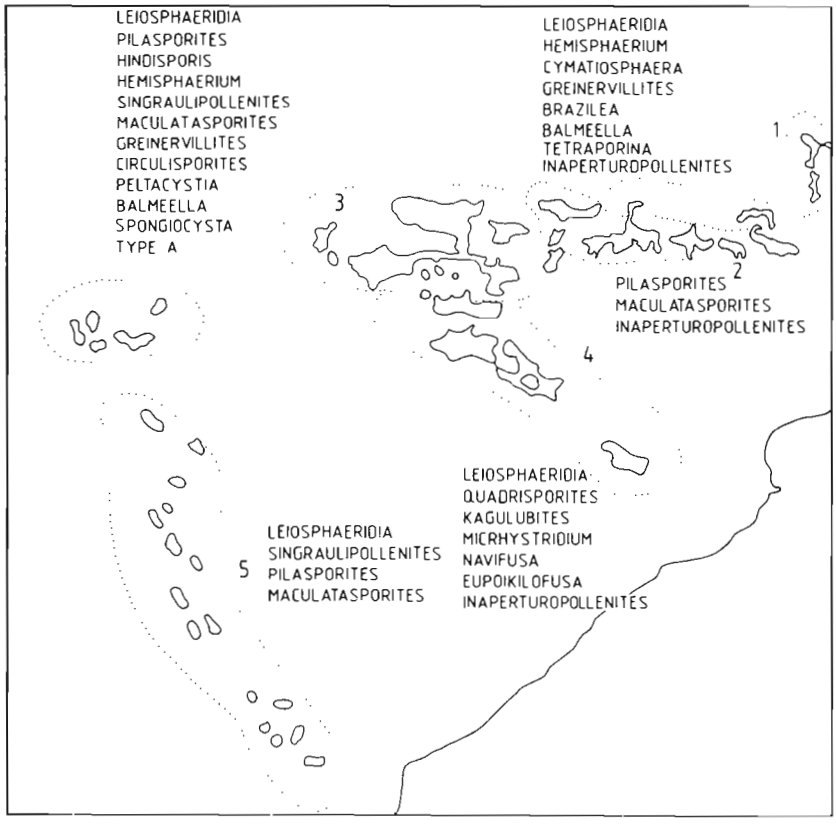
Brazilea	*Spirogyra*
Kagulubites	*Spirogyra*
Singraulipollenites	*Zygnema*
Maculatasporites	*Zygnema*

Recently the taxa *Muratticavea, Cymatiosphaera, Eupoikilofusa, Schismatosphaeridium, Navifusa* and *Tympanicysta* are recorded in addition to already known forms from the subsurface Permian-Triassic sediments of Talcher Coalfield and Rajmahal area. The presence of *Micrhystridium* in Talcher Coalfield (Tripathi, 1996) and *Veryhachium* in Godavari Graben (Surésh C. Srivastava, personnel communication) in Late Permian sediments is noteworthy.

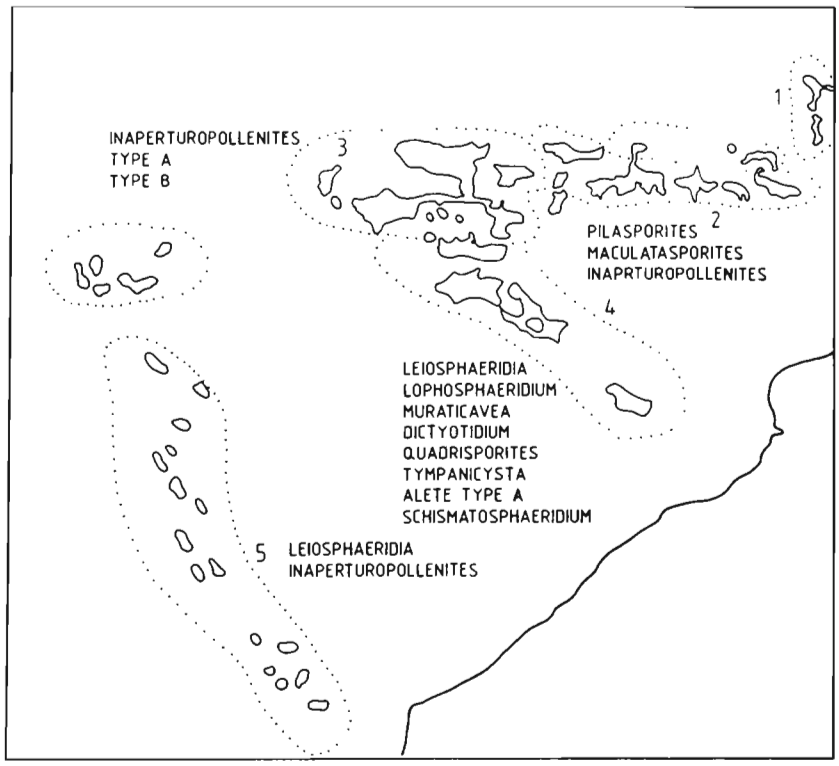
DISCUSSION

Bringing together all the available reports of Late Permian and Triassic acritarch genera, Text-figures 2 and 3 are drawn, respectively showing occurrences of various taxa in different basins. Summarising the data at hand, the qualitative and quantitative representation of acritarchs at a glance is depicted in Text-figure 4. During Permian a High Form Diversity (HFD) is observed in Rajmahal, Son and eastern part of Mahanadi basins and Medium Form Diversity (MFD) in Godavari Graben. It is noted that the HFD is reported from coalfacies in Talcher and Singrauli coalfields, while MFD in Godavari Graben. The clay lithofacies in Rajmahal Basin shows HFD while in Godavari the condition is reverse, the clays have a level of Low Form Diversity (LFD). In Raniganj Coalfield which provides complete and continuous palynosequence from Late Permian to Early Triassic, LFD is on record throughout. Analysing the quantitative distribution of acritarchs during Late Permian it is clear that High Quantity (HQ) is recorded in Rajmahal, Son and Godavari and Low Quantity (LQ) in Talcher and Damodar.

The representation of acritarchs in the Early Triassic sequence (Text-figure 4) indicates a LFD in Raniganj and Korar, HFD in Talcher Coalfield, and LFD in Godavari Graben. Regarding the quantitative occurrence LQ in Damodar and Son basins, MQ in Godavari Graben and HQ in Mahanadi Basin is recorded.



Text-figure 2—Occurrence of acritarchs during Late Permian in peninsular India. Numbers 1-5 represent Rajmahal, Damodar, Son and Mahanadi basins and Godavari Graben, respectively.



Text-figure 3—Occurrence of acritarchs during Early Triassic in peninsular India. The numbers 1-5 represent Rajmahal, Damodar, Son and Mahanadi Basins and Godavari Graben, respectively.

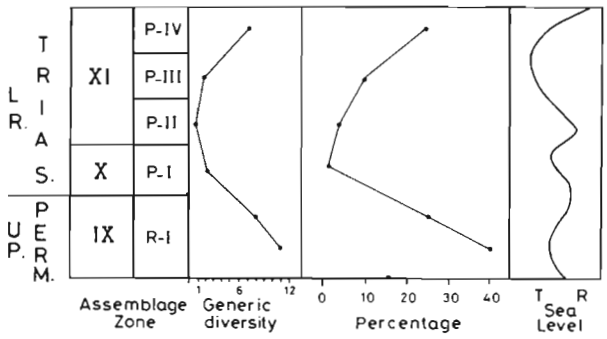
Summing up the data in nut shell the diversity (at generic level) and frequency curves are drawn (Text-figure 5). The curves reveal fluctuations in diversity and frequency both. During Late Permian the diversity and frequency both were high which gradually go down in the earliest Triassic. During late Early Triassic a prominent increase is evidenced in diversity as well as richness.

SYSTEM	PALYNOZONE (1)	PALYNOZONE (2)	RAJMAHAL	DAMODAR	SON	MAHANADI	GODAVARI
LOWER TRIASSIC	*Playfordiaspora cancellosa*	P-IV		LFD. LQ		HFD. HQ	
		P-III		LFD. LQ			LFD. HQ
		P-II		LFD. LQ			
	Krempi-pollenites indicus	P-I		LFD. LQ	LFD. LQ		
UPPER PERMIAN	*Densipollenites magnicorpus*	R-I	HFD. HQ	LFD. LQ LFD. LQ	MFD. HQ HFD. HQ	HFD. LQ	MFD. HQ LFD. HQ

FD - FORM DIVERSITY: Q - QUANTITY. L - LOW M - MEDIUM, H - HIGH
LFD - < 2: MFD - 2-4, HFD - > 5: LQ - 1-5%, MQ - 5-10%, HQ - > 10%

Text-figure 4—Summary of qualitative and quantitative representation of acritarchs across the Permian-Triassic Boundary in peninsular India.

There are two aspects of acritarch usage-stratigraphical and palaeoecological. The stratigraphical aspect is proved promising for the Early Palaeozoic sequences as most of the forms appear by Devonian and towards the end of Devonian "phytoplankton blackout" is recognised (Riegel, 1996). For deducing palaeoecology and palaeoenvironment the presence of *Micrhystridium* and *Veryhachium* in Late Permian palynoassemblage, although rare, is significant, as these represent definite marine environment; these may represent increased salinity due to backflow of sea water during transgression. Similarly *Cymattosphaera* and *Muratticavea*, known from the Early Palaeozoic marine sediments, are present in the Late Permian of Rajmahal Basin and late Early Triassic of Talcher Coalfield, respectively. *Cymattosphaera* and *Muratticavea* of Herkomorphitae Group show affinity with Prasinophyceae. According to Colbath and Grenfell (1995), the prasinophytes, having established fossilisation potential, are restricted to marine microplankton. Hence, the two taxa provide information regarding the increased salinity during Late Permian and late Early Triassic. Strikingly the abundance of *Muratticavea* to the extent of dominant



Text-figure 5—Diversity and frequency curves of acritarchs and the sea level changes in Late Permian and Early Triassic period (sea level changes adapted after Vail *et al.*, 1977).

category in the late Early Triassic sediments of Talcher Coalfield corroborates with the regressive phase of Early Triassic transgression (Text-figure 4). This provides a clue for the Early Triassic transgression in India although no physical evidences are known so far.

CONCLUSIONS

From the preceding account following conclusions are drawn:

1. High Form Diversity is evidenced during latest Permian.
2. During latest Permian High Quantity is present in Rajmahal and South Rewa Gondwana basins and Godavari Graben.
3. Low to Medium Form Diversity is observed during Early Triassic in Damodar and South Rewa Gondwana basins.
4. High Form Diversity and High Quantity occur during late Early Triassic in Talcher Coalfield.
5. The presence of taxa *Micrhystridium, Veryhachium* and *Cymatiosphaera* in the Late Permian sediments and the abundance of taxa *Muratticavea* in late Early Triassic sediments provide clues for the Late Permian and Early Triassic transgression in India.

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