Palynology of the Cretaceous-Tertiary transition in an Atlantic bore-core, off Senegal Coast, West Africa

B.S. Venkatachala, R.K. Kar, A. Rajanikanth & A. Ly

Palynological investigations on the Cretaceous-Tertiary transition in the bore-hole no. CM 5 drilled in the Atlantic Ocean, off Senegal Coast, West Africa have been carried out. According to the stratigraphic data the top of the Maestrichtian is marked approximately at 952 m. The present study is aimed to detail out palynological data and correlate with stratigraphic information. Samples of the sediments between 1002-944 m levels have been investigated in detail. It is observed that palynological assemblage recovered from sediments at 1002-958 m show an almost uniform distribution of taxa. Significant Maestrichtian marker taxa namely Diporoconias iszkazentgyoergyi, Ariadnaesporites aradiiae, Gabonisporites vigourouxii, Periretisyncolpites magnosagenatus, Tercissus grandis, Longapenites marginatus etc., are recorded. These marker taxa disappear at 958 m level and an abundance of pteridophytic spores is noticed. Thus a major change in floral composition is recorded at this level marking K/T transition, which is characterised by the disappearance of Maestrichtian marker taxa and presence of a fern-spike. Such major floral change is attributed to possible influence of K/T events.

Key-words—Palynology, Cretaceous-Tertiary Transition, Atlantic Ocean, West Africa.

R.K. Kar & A. Rajanikanth, Birbal Sahni Institute of Palaeobotany, 53 University Road, Lucknow 226 007, India.
B.S. Venkatachala, Wadia Institute of Himalayan Geology, 33 General Mahadeo Singh Road, Dehradun 248 001, India.
A. Ly, Faculte des Sciences et Techniques, Universite Cheikh Anta Diop, Dakar, Senegal.

THE Cretaceous-Tertiary boundary is one of the most controversial topics of the geological sciences today. Many hypotheses have been put forward to explain the total extinction of some of the animals. Dinosaurs, that ruled the earth almost for the entire Mesozoic Era, disappeared by the end of Maestrichtian. The K/T extinction of calcareous nannoplankton in the marine realm too was called a “biotic crisis” (Percival & Fisher, 1977). While working on the K/T calcareous microplankton and related isotope stratigraphy, Percich-Nielson, McKenzie and He (1982) recognised catastrophic event”. Alvarez et al. (1980) suggested collision of an extraterrestrial body with the earth resulting in large scale extinction of animals. The shocked quartz found in many parts of the world (including India) is regarded as the signature of this impact. It is also suggested that the Deccan volcanic activity at the K/T boundary released toxic gases such as CO₂,
NO\textsubscript{2} and SO\textsubscript{2} and affected profound changes in the biotic realm (Sahni et al., 1996).

Land plants were no exception to the K/T events. Evidences throughout the world indicate significant changes. It was shown that a discontinuity marked in composition of palynological assemblages at the K/T boundary in Gabon and Cameroun, West Africa (Boltenhagen & Salard, 1980). This was attributed to the cooling at the advent of Palaeocene. Nichols (1990) remarked that marked variations in palynoassemblages from New Mexico to Alberta at K/T boundary were due to disappearance/appearance of forms. Tschudy (1971) observed an impoverished palynological records from the Rocky Mountains and Mississippi regions. Tschudy and Tschudy (1986) observed an abrupt disappearance of Proteacidites and Aquilapollenites in the Western Interior basin at the K/T boundary. In the southern part Tilia woodhousii and Trisectoris along with Proteacidites were not found beyond Maestrichtian though some other species cross the K/T boundary. Boulter et al. (1988) illustrated four types of changes in pollen assemblages at the K/T boundary observed by Tschudy and Tschudy (1986). In the first type abrupt regional disappearance is marked. In the second type evolution of new types is noticed and in the third, extension of flora beyond the K/T boundary is observed only to disappear later. In the last type there is hardly any change at the K/T boundary, almost all the species continue in the Palaeocene. Dorf (1942) found a more diversified fossil leaf flora in the Upper Cretaceous than in the Palaeocene in North America. Widespread paucity of flora corroborates the change in the climate at the advent of Palaeocene.

The Senegal Basin was known for its geological and palynological contribution. The surface and sub-surface geology of Senegal and Atlantic Ocean adjacent to it was worked out by Castelain (1964), Splengler et al. (1966), Templeton (1971), Sarr (1982), Mitchaud (1984), Ly (1985), Pritan (1986) and others. Palynological investigations were carried out by Jardine and Magloire (1965), Kieser (1967), Medus et al. (1988), Babinot et al. (1988), Caratini et al. (1991) and others. Jain and Millepied (1975) worked out systematics and biostratigraphy of phytoplankton ranging in age from Aptian to Maestrichtian in a number of bore core samples off Senegal Coast.

The present investigations are aimed to know the pollen behaviour at the K/T boundary in the samples of the bore hole core no. CM 5. The core was drilled in Atlantic Ocean about 61 km west of Senegal Coast (Text-figure 1) and is situated in the Senegal Basin. The samples were studied at 10 m interval approximately and are of Campanian (1550-1300 m), Maestrichtian (1300-952 m), Palaeocene (930-750 m), Eocene (750-450 m), Oligocene (450-380 m) and Miocene (380-90 m) age. The present report is, however, confined only to the K/T transition. The samples belonging to Upper Maestrichtian are grey-green clay, sandy with layers of sandy clay and occasionally calcareous and glauconitic. The

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**PLATE 1**

(All photographs ca. x 500)

1. Triporolites sp., Slide no. BSIP 11490 W 26/1.
2. Todisporites minor, Slide no. BSIP 11491 W 43/3.
4, 15, 17, 18. Ariadnaesporites ariaidae, Slide no. BSIP 11492 U 37/1; Slide no. BSIP 11492 T 25/4; Slide no.BSIP 11493 M 23; Slide no. BSIP 11493 Q 33/3.
5. Matanomadialisculites maximus, Slide no. BSIP 11490 H 29.
8. Diproconia iszkassentievii, Slide no. BSIP 11493 U 34/3.
9, 11, 16, 20. Tercissus grandis, Slide no. BSIP 11493 T 18/1 Slide no. BSIP 11491 T 28/4; Slide no. BSIP 11490 E 19/3; Slide no. BSIP 11493 N 31/2.
10. Bacutriporites ardenensis, Slide no. BSIP 11492 0 5/2.
13. Phragmothyrites eocenicus, Slide no. BSIP 11493 G 36; Slide no. 11492 G 30/1.
14, 22. Gabonisporites vigourouxii, Slide no. BSIP 11493 T 28; Slide no. 11490 E 16/4.
samples at the basal part of Palaeocene are fine limestone and black marl. The samples were treated with HCl, HF and HNO₃, followed by a treatment of 5% KOH. The slides were prepared in Polyvinyle alcohol and mounted in Canada balsam. The slides are preserved at the repository of the Birbal Sahni Institute of Palaeobotany, Lucknow.

The top most Maestrichtian was marked approximately at 952 m and the Early Palaeocene at 930 m in the bore hole core. The depth between 950-935 m was kept uncertain between Maestrichtian to Palaeocene. The nature of the sediments between 1000-935 m is more or less same and consists of fine limestone and black marl (Text-figure 2).

Samples at the depth of 992 m, 982 m, 968 m, 958 m, 950 m and 944 m were studied critically to demarcate K/T transition through palynological investigations. Samples between 992-968 m yielded Bacutriporites orluensis, Echitriporites triangularis, Longapertites marginatus, Proxapertites cursus, Proxapertites operculatus, Matanomadhiasulcites maximus, Spinizonocolpites echinatus, Diporoconia

Text-figure 2—Litholog of the bore hole core no. CM 5.
iszkaszentgyoergyi, Diporoconia sp., Tercissus grandis, Periretisyncolpites magnosagenatus, Azolla cretacea, Gabonisporites vigourouxiı, Ariadnaesporites ariadnae, Triporoletes reticulatus, Todisporites major, Cyathidites minor, Osmundacidites wellmanii, Dandotiaspora plicata, Phragmothyrites eocenicus and spores of Achrostichumsporites (Pl. 1).

Of all these species Ariadnaesporites ariadnae is the most common particularly at the lower level samples. Other common species include Tercissus grandis, Matanomadhisulcites maximus, Periretisyncolpites magnosagenatus, Gabonisporites vigourouxiı, Diporoconia iszkaszentgyoergyi, Bacutriporites orluensis and Longapertites marginatus (Text-figure 3).

Jardine and Magloire (1965) recorded
Aquilapollenites from the Late Maestrichtian of Senegal. They also observed the presence of Proteacidites in Senonian and Maestrichtian in the same region. Besides, Stover (1963) noted the occurrence of Pembixipollenites in the Middle Cretaceous of Senegal and Ivory coast. All these genera are, however, not recorded in the present assemblage.

At the depth of 958 m, a profound change is observed in the palynological assemblage. Common elements like Ariadnaesporites ariadnae, Bacutriporites orluensis, Longapertites marginatus, Tercissus grandis, Gabonisporites vigourouxii and Periretisyncolpites magnosagenatus are not recorded.

Matanomadhiasulcites maximus, Azolla cretacea, Proxapertites operculatus and Proxapertites cursus are rarely met with. The assemblage is dominated by pteridophytic spores represented mostly by Cyathidites minor, Todisporites major and Lygodiumsporites lakiensis. Other pteridophytic spores occasionally found are Lycopodiumsporites speciosus, Pteridacidites sp., and Polypodiaceaesporites sp.

Neocouperipollis kutchensis is the other angiospermic pollen occasionally found in the assemblage. Almost all marker species of Late Maestrichtian and Early Palaeocene, viz., Ariadnaesporites ariadnae, Gabonisporites vigourouxii, Tercissus grandis, Triporoletes reticulatus, Periretisyncolpites magnosagenatus, Proxapertites cursus, Proxapertites operculatus and Dipoconia iszkaszentgyergyi disappear at the depth of 950 m. Matanomadhiasulcites maximus and Azolla cretacea are the only two species which still continue. The assemblage is overwhelmingly dominated by laevigate, trilete pteridophytic spores. The commonest of these forms are Cyathidites minor, Todisporites major and Lygodiumsporites lakiensis. Other species are also occasionally met with which include Lycopodiumsporites speciosus, Dictyophyllidites sp., and Cycas pollen. Among angiosperms Neocouperipollis kutchensis is rarely found.

Fastovsky (1987) studied the palaeoenvironmental condition of deposition during Cretaceous-Palaeocene transition in eastern Montana and western north Dakota, U.S.A. and advocated that at the end of Cretaceous the water table presumably rose to the surface causing ponds and swamps. This condition was congenial for luxuriant growth of ferns.

At the depth of 944 m, the revival of some of the old species is recorded. Ariadnaesporites ariadnae, Tercissus grandis, Gabonisporites vigourouxii, Bacutriporites orluensis, Longapertites marginatus, Periretisyncolpites magnosagenatus, Proxapertites cursus and Proxapertites operculatus again appear. The assemblage is, however, continued to be dominated by pteridophytic spores. Cyathidites minor, Todisporites major and Lygodiumsporites lakiensis are found in good percentage.

At the higher level, Ariadnaesporites ariadnae is no more found though the rest of the species enumerated above continue up to Palaeocene. It is significant that Ariadnaesporites equipped with prominent acrolamelle and distally profuse hair like outgrowth which provided the buoyancy to float, should perish while the angiosperms after initial set back could regenerate. Ariadnaesporites being a hydrophyte depended much on the nature of water for propagation and survival whereas the angiospermic plants mostly inhabited terrestrial environments.

Why the angiosperms started disappearing at the depth of 958 m and almost completely disappeared at 950 m is a question to ponder. Perhaps the environment was not congenial for their growth between 958-950 m. The reappearance of most of the forms at 944 m indicates that condition was returning to normal.

Emergence of pteridophytic spore as the dominant element during this period also indicates the large scale destruction of the then existing angiosperms in the surrounding area. After their deterioration, the land was void and invaded by the pteridophytes and other plants. This change in plant community is reflected in the
palynological constituents of the samples.

Similar pteridophytic spore peak period was also observed in the Raton Basin and Hell Creek, Western Interior, U.S.A. at the K/T boundary by Tschudy et al. (1984). They observed the dominance of fern spores from 70-100% and mostly represented by Cyathidites. Similar "fern-spike" was also noticed by others in many localities in the U.S.A. though Lerbeckmo et al. (1987) failed to observe it in Canada. Saito et al. (1986) also observed the dominance of fern spores in a marine sequence at the K/T boundary in the Raton Basin observed the dominance of ferns at this juncture and depauperation of early existing flora gradually gave rise to diversified assemblage later. As many ferns are rhizomatous, they may survive in volcanic areas covered by ash for many years. Besides in ferns and monocots the aerial stems are protected by retained leaf bases which could save apical meristems from burning up to a great extent. If we consider these adaptable characters for ferns then it would be easy to understand why this group should dominate at the terminal Cretaceous event.

The temporary disappearance of existing flora during Cretaceous-Tertiary transition and the evolution of a new one perhaps point out an abrupt change in the environment. The cause might be attributed to any catastrophic event. The critical period is represented by sediments between 958-950 m which witnessed abrupt destruction of the previous flora and appearance of new taxa. Since extinction of flora started at 958 m, this may be regarded as terminal level of the Maestrichtian in the bore hole core.

ACKNOWLEDGEMENT

Sincere appreciation is expressed to Professor Ivan de Klasz, Nice, France for supplying the samples for palynological investigations.

REFERENCES


