A PALYNOLOGICAL APPROACH TO THE STUDY OF QUILON BEDS OF KERALA STATE IN SOUTH INDIA

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ABSTRACT

The paper deals with the main results of a palynological study of the Quilon beds exposed at Padappakkara, Paravur and Edvai in the Kerala State of South India. A large number of hystrichosphaerids, acritarchs, numerous kinds of spores of pteridophytes and pollen grains of angiosperms and a fairly good number of fungal fruit bodies and spores have been recovered from the clays of these beds. The pteridophytes are represented by Lycopodiaceae, Gleicheniaceae, Ophioglossaceae, Schizaeaceae. Adiantaceae, Dicksoniaceae, and Polypodiaceae, of which the spores of Polypodiaceae-Dicksoniaceae complex constitute the predominant elements. The angiosperms are represented by the pollen of Potamogetonaceae, Aroideae, Palmae, Liliaceae, Lemnaceae, Gramineae, Nymphaeaceae, Menispermaceae, Euphorbiaceae; Vitaceae, Combretaceae, Ebenaceae, Loranthaceae, Dipterocarpaceae, Sapindaceae, Oleaceae; Lecythidaceae, Simarubaceae, Rubiaceae, Araliaceae, Symplocaceae, Anacardiaceae, Rhizophoraceae, Bombacaceae, Hippocrateaceae, Caesalpiniaceae, Aquifoliaceae, Nyssaceae, Caprifoliaceae, Compositae, Ctenolophonaceae, Labiateae, Meliaceae, Sapotaceae, Polygalaceae, Proteaceae, Haloragaceae, Sonneratiaceae, Olacaceae, Thymeliaceae, Moraceae and Droseraceae.

The abundance of Polypodiaceae-Dicksoniaceae spores, and the occurrence of *Pteridacidites, Intrabaculisporis, Eximospora, Cingulatisporites, Cibotidites* and the pollen grains referable to Compositae (*Compositoipollenites*), Sonneratiaceae (*Verrutriporites*), Dipterocarpaceae (*Foveoretitricolpites*), Combretaceae (*Pseudocolpopollis*), and Droseraceae (*Ornatetradites* and *Droseridites*) indicate a Miocene age for the Quilon beds. The spore and pollen assemblage recovered generally supports the Lower to Middle Miocene age assigned to Quilon beds, by the earlier workers on the basis of faunal evidence.

The spore and pollen assemblage along with the microthyriaceous fungal fruit bodies clearly points towards a tropical humid climate with plenty of rainfall during the Neogene period of Kerala.

The Neogene flora of the Quilon beds was essentially of the coastal type and indicates the presence of brackish water swamps and lagoons along the coast line.

INTRODUCTION

KING[1], as early as 1882, classified the vast Tertiary sediments of the Kerala State in South India into the Lower Quilon beds consisting of fossiliferous limestones, carbonaceous clays, calcareous clays and sands, and the Upper Warkalli beds of variegated sands, white plastic clays, carbonaceous clays and associated seams of lignite. The entire Tertiary sequence of Kerala rests directly upon the Archaeans and itself is overlain by a variable thickness of recent to subrecent marine and estuarine sediments.

The Kerala Tertiaries extend all along the coast of that state almost continuously from Cape Comorin in the South to Manjeshwar, bordering the Mangalore District of Mysore in the North. They clearly reveal two major basins of deposition, *viz.*, (1) between Trivandrum and Ponnani in the South including central Kerala, and (2) between Cannanore and Kasargod in North Kerala. The Quilon beds were originally believed to be of limited extent confined to the type locality at Padappakkara. Subsequently Kumar and Pitchamuthu[2] traced the Quilon limestones towards Nedungulam, Paravur and Varkallai and Damodaran[3] located them at Edvai. Jacob and Sastry[4] identified this limestone in a bore hole from Chavara. Poulose and Narayanaswamy[5], more recently, indicated that the marine calcareous beds spread over a considerable area from Varkallai in the South to Shertallai in the Northern part of Kerala under the cover of recent deposits.

The Quilon beds are best exposed in the southern basin at Padappakkara 11 Km north-east of Quilon and also at Nedungulam, Edvai, Paravur and in the drill holes north of Varkallai. The limestone is richly fossiliferous containing numerous, often beautifully preserved, specimens of foraminifera, corals, echinoids, molluscs, ostracods and crabs. In the northern basin, the Quilon beds are very insignificant and particularly located at the base of the sea cliff near Meenkunnu 6 Km north of Cannanore.

King[1], who on lithological similarity considered the Warkalli beds overlying the Quilon's as equivalent to the Cuddalore sandstones of Tamil

Nadu, assigned a Middle Miocene age to the Quilon beds. Jacob and Sastry[4] on the basis of a study of foraminifera from a bore hole at Chavara assigned a Lower Miocene (Burdigalian) age to these beds. Subsequently Dey[6] from an exhaustive study of the molluscan fauna from Padappakkara considered the Quilon's to be of Middle Miocene (Vindobanian) age.

Palynological Results

Palynological investigations of the Kerala Tertiaries in general and the Quilon beds in particular have been very few and far between. The authors have undertaken this study with the express purpose of providing a comprehensive account of the palynological assemblages of the Quilon and Warkalli sediments so that they may be meaningfully utilized not only for stratigraphical purposes but also to unravel the floristic complexes and palaeoclimatical set up during the Neogene of Kerala and to assess and evaluate the nature of the depositional environment during this period. The following are the main results of the authors' study with regard to the Quilon sediments, the detailed account of which would be published elsewhere.

The material used in this study consists of a large number of samples of clay, often with many invertebrate remains in varying degrees of preservation, and darkish carbonaceous clays from the Quilon beds exposed at Padappakkara, Paravur and Edvai.

Palynologically the Quilon clays are found to be extremely rich. A number of hystrichosphaerids, acritarchs, and a galaxy of excellently preserved spores of pteridophytes and pollen grains of angiosperms and a fairly sizeable number of fungal fruit bodies and spores have been recovered from these clays by suitable maceration techniques. The angiosperm pollen grains constitute the predominant elements of the Quilon microflora. No gymnospermous pollen grains, either winged or unwinged, have been encountered in any of the large number of samples studied.

The pteridophytic spores are referable to Lycopodiaceae, Gleicheniaceae, Ophioglossaceae, Dicksoniaceae, Adiantaceae, Schizaeaceae, and Polypodiaceae. Of these, the spores of Polypodiaceae-Dicksoniaceae complex are profusely represented and next in the order of numerical importance are Lycopodiaceae and Schizaeaceae. The following are some of the important taxa recorded by the authors, *viz.*, *Lygodiumsporites padappakkarensis* sp. nov., *Intrabaculisporis quilonense* sp. nov., *Gleichenidites cercinidites*, *Eximospora sparsus* sp. nov., *Verrucosisporites dakshinensis* sp. nov., *V. pulvinulatoides*, *V. paravurensis* sp. nov., *Foveosporites raoi* sp. nov., *Foveotriletes bifurcatus* sp. nov., *Lycopodiacidites caperatus*, *Cibotidites kundavaensis*, *Cingulatisporites miocenicus* sp. nov., *Pteridacidites sahii* sp. nov., *Laevigatosporites ovatus*, *Polypodiisporites impariter*, *P. ornatus*, *P. perverrucatus*, *P. multiverrucatus*, and *Schizaeoisporites multistriatus* sp. nov.

The angiosperms constituting the largest contingent of the Quilon microflora are represented by the pollen of both monocotyledons and dicotyledons. The monocotyledons are represented by the pollen of Potamogetonaceae (*Retipilonapites tertiaris* sp. nov., *R. arcotense*), Aroideae (*Spinainaperturites neogenicus* sp. nov., *Retialetes quilonensis* sp. nov.), Liliaceae (*Liliacidites padappakkarensis* sp. nov., *L. densireticulatus*), Palmae (*Palmaepollenites keralensis* sp. nov., *P. neyvelii*, *P. longisulcus* sp. nov., *Arecipites punctatus* sp. nov., *Verrumonocolpites indicus* sp. nov., *Couperipollis punctitectatus* sp. nov., *C. ellipticus* sp. nov., *Clavapalmaedites hammenii* gen. et sp. nov., *Echinosulcites ovatus* gen. et sp. nov., *Paravuripollis mulleri* gen. et sp. nov., *Edvapollis punctatus* gen. et sp. nov., *Longapertites hammenii* sp. nov., *Quilonipollenites salnii* gen. et sp. nov., *Dicolpopollis padappakkarensis* sp. nov., *D. minutus* sp. nov., *D. longicolpatus* sp. nov., and *Spinozonocolpites quilonensis* sp. nov.), Lemnaceae (*Spinamonoporites indicus* sp. nov.), and Gramineae (*Monoporopollenites gramineoides*). Of these the pollen of Palmae is very abundantly represented and shows significant resemblances with the pollen of the modern palms such as *Cocos*, *Hyphaene*, *Areca*, *Pinanga*, *Iriartea*, *Lepidocaryum*, *Nipa*, *Calamus* and *Metroxylon*.

Pollen grains referable to the following assemblage of the dicotyledonous families have been recognized in the Quilon beds, *viz.*, Nymphaeaceae, Menispermaceae, Euphorbiaceae, Vitaceae, Combretaceae, Ebenaceae, Loranthaceae, Dipterocarpaceae, Sapindaceae, Oleaceae, Lecythidaceae, Simarubaceae, Rubiaceae, Araliaceae, Symplocaceae, Anacardiaceae, Rhizophoraceae, Bombacaceae, Hippocrateaceae, Caesalpiniaceae, Aquifoliaceae, Nyssaceae, Caprifoliaceae, Compositae, Ctenolophonaceae, Labiateae, Meliaceae, Sapotaceae, Polygalaceae, Proteaceae, Haloragaceae, Sonneratiaceae, Olacaceae, Thymeliaceae, Moraceae and Droseraceae. The commonly represented taxa are, *viz.*, *Crotonoidaepollenites euphorbioides* gen. et sp. nov., *Retitricolpites grandis* sp. nov., *R. americana*, *Retitrescolpites indicus* sp. nov., *Foveotricolpites pierrei* sp. nov., *Crototricolpites densiclavatus* sp. nov., *Loranthipites elegans* gen. et sp nov., *Margenipollis quilonensis* sp. nov, *M. kutchensis* comb. nov., *Ctenolophonidites costatus*, *Polycolpites granulatus*, *Pseudocolpopollis combretoides* gen. et sp. nov., *Cauveripollis superbus*, *Hippocrateaceaedites quilonensis* sp. nov., *Zonocostites indicus* sp. nov., *Palaeocoprosmadites keralensis*

sp. nov., *Gothanipollis indicus* sp. nov., *Compositoipollenites argutus*, *Bombacacidites minutus* sp. nov., *Costaripollenites pauciornatus*, *Cupaniedites punctatus* sp. nov., *Margocolporites oligobrochatus*, *M. tsukadai*, *Sapotaceoidaepollenites africanus*, *S. neyvelii*, *S. keralensis* sp. nov., *Meliapollis quilonensis* sp. nov., *Polygalacidites ovatus*, *Myricipites harrisii*, *Maculoporites quilonensis* sp. nov., *Verrutriporites perverrucatus* sp. nov., *Tetrapollis quadrangularis* sp. nov., *T. ornatus* sp. nov., *Haloragacidites delicatus* sp. nov., *H. neyvelii*, *Parsonsidites couperi* sp. nov., *Anacolosidites luteoides*, *Clavaperiporites jacobi*, *Ornatetradites droseroides* gen. et sp. nov., and *Droseridites minor* sp. nov.

On the whole among the angiosperms the pollen of arborescent plants predominates over that of the herbaceous ones. The rarity of the pollen of Gramineae points towards the paucity of grass cover in the vegetation The majority of the pollen grains exhibit various kinds of exine sculpturing, often of a very ornate type, which incidentally indicates that they were produced by entamophilous plants growing in and around the vicinity of the depositional basin and that there was not much of long distance transportation of the grains.

The hystrichosphaerids of the Quilon microflora consist of species of *Achmosphaera*, *Cleistosphaeridium*, *Hystrichosphaeridium*, *Spiniferites* etc., and the acritarchs include the species of *Baltisphaeridium*. The fungal fruit bodies are referable to microthyriaceous (ascomycetous) fungi.

The abundance of the spores of the Polypodiaceae-Dicksoniaceae complex, and the occurrence of *Pteridacidites*, *Intrabaculisporis*, *Cingulatisporites*, *Cibotidites* and the pollen grains of Compositae (*Compositoipollenites*), Sonneratiaceae (*Verrutriporites*), Dipterocarpaceae (*Foveoretitricolpites*), Combretaceae (*Pseudocolpopollis*), and Droseraceae (*Ornatetradites*, *Droseridites*) point towards the Miocene age for the Quilon beds. The Quilon microfloral assemblage is fairly comparable with the Miocene assemblages of the Eniwetok, Fiji, Bikini and Palau islands of the South Pacific area[7], Neyveli lignite and Cauvery basin of Tamil Nadu[8,9], Bengal basin[10], and the Rusizi valley of Burundi[11]. While it is not possible at this stage to be specific as to the exact horizon of the Quilon beds within the Miocene age, the spore and pollen assemblage we have recovered generally supports the Lower to Middle Miocene age (Burdigalian to Vindobanian) assigned to these beds by the earlier workers on faunal evidence[4,6,12].

Consideration of Palaeoclimate and Depositional Environment

A overwhelming majority of the taxa with recognizable botanical affinities indicate the presence of either exclusively or chiefly tropical families in the Quilon flora. Mention must be made in this connection of the occurrence of such families as Gleicheniaceae, Schizaeaceae, Polypodiaceae, Aroideae, Palmae, Lecythidaceae, Araliaceae, Symplocaceae, Rhizophoraceae, Sonneratiaceae, Bombacaceae, Hippocrateaceae, Caesalpiniaceae, Combretaceae, Sapotaceae, Dipterocarpaceae, Ctenolophonaceae, Meliaceae, Olacaceae, Anacardiaceae, and Droseraceae. The abundance of ferns and the presence of Dipterocarpaceae, Ctenolophonaceae, Olacaceae and *Duabanga* of Sonneratiaceae points towards heavy precipitation. It thus appears that the climate during the Neogene of Kerala was of the tropical humid type with plenty of rainfall. As the modern climate of Kerala is of the same kind, one is tempted to presume that perhaps there had not been much of a change in the climate of this region since the Neogene times.

A critical analysis of the diverse kinds of microfloral elements recorded clearly indicate that neritic, shallow marine to brackish water conditions prevailed during the deposition of the Quilon beds. The earlier faunal evidence also pointed to the same environment. There is no doubt that the Neogene Quilon flora was essentially of a coastal type. The record of pollen grains resembling such accredited mangrove taxa as *Barringtonia* of Lecythidaceae, *Rhizophora* of Rhizophoraceae, *Lumnitzera* of Combretaceae, *Nipa* and *Iriartea* of Palmae clearly testifies to the presence of brackish water swamps and lagoons along the coast line. Present immediately interior to the mangrove belt of the vegetation there were probably a number of fresh water ponds dotting the landscape as evidenced by the occurrence of the pollen grains of Potamogetonaceae, Lemnaceae, Nymphaeaceae, and *Myriophyllum* of Haloragaceae.

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