JOURNAL OF THE PALAEONTOLOGICAL SOCIETY OF INDIA
VOL. 36, 1991, PP. 51-58

PALYNOASSEMBLAGES OF THE SUBSURFACE TERTIARY STRATA AT PATTANAKAD, ALLEPPEY DISTRICT, KERALA STATE

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ABSTRACT

The paper incorporates an analysis of the palynoassemblages recorded from the Tertiary sequence comprising Ambalapuzha (terrigenous), Quilon (marine) and Mayyanad (terrigenous) Formations encountered in a 274. 31 m deep borewell in the Alleppey district of Kerala State. The spore and the pollen taxa recorded from all these three formations are more or less of the same type, although palm pollen types enjoy better representation in the Quilon Formation. The consistent occurrence of Polypodisporites (abundantly), Striatriletes, Crassoretitriletes, *Pteridacidites, Quilonipollenites, Compositoipollenites, Lacrimapollis, Pachydermites, Grimsdalea, Retitriporites, Ornatetradites, Bombacacidites* and *Polygonacidites* indicates an Early Miocene age to the Tertiary deposits encountered in Pattanakad borewell. The palynoflora suggests a coastal to near coastal tropical moist vegetation during the Early Miocene of Kerala.

INTRODUCTION

According to a recent lithostratigraphic classification based upon an overall analysis of the exposed and subcrop lithofacies and their interrelationships (Raha, Roy and Rajendran, 1983), the entire Caenozoic sequence of Kerala has been designated as the Malabar Supergroup, encompassing the Quaternary-Holocene Vembanad Formation and the Tertiary Warkalli Group. A laterite horizon marking a distinct unconformity demarcates the Vembanad Formation from the Warkalli Group. The Warkalli Group best developed in its entirity in the subsurface, consists of Ambalapuzha, Quilon and Mayyanad Formations from top to bottom. The Ambalapuzha and Mayyanad Formations are terrigenous, while the Quilon Formation is essentially marine.

Information pertaining to the palynology of the subsurface Tertiary sequence of Kerala State has been meagre to date. Raha, Rajendran and Kar (1987) made some interesting and significant palynological observations on the basis of their spore and pollen analysis of a 600 m deep borewell near Ambalapuzha. A good number of marker palynomorphs referable to the Early Miocene, Oligocene and Eocene horizons were recorded in this borewell. The Palaeogene elements were encountered from 279 m down to 443 m (Oligocene) and 443 m down to 584 m (Eocene). Ramanujam, Muralidhar Rao and Reddy (1990) very recently provided fairly substantial information on the palynoflora of the subsurface Tertiary strata encountered in a borewell at Mynagapalli of the Quilon district.

The present contribution deals with a rich spore and pollen complex recovered from the drill cuttings of a borewell at Pattanakad in the Alleppey district of Kerala State and evaluates its floristic, palaeoenvironmental and stratigraphic significance.

MATERIAL AND METHODS

The material obtained from the Kerala circle of the Central Ground Water Board (CGWB) consists of numerous (Twenty five) palynosamples (drill cuttings) from both the terrigenous and marine sequences encountered at different depths of a borewell at Pattanakad (9^0 44' : 78^0 18') in the Alleppey district of Kerala State (Fig. 1). Fig. 2 shows the lithology of the Pattanakad borewell and the various depths which provided palynosamples for the present study. The Pattanakad Borewell is 274. 3 m deep and shows the following major lithological sequence (information kindly provided by CGWB):

Ground level to 60.9m	Fine to medium sand, greyish white clay, bluish grey clay.
60.9 to 103.63m	Continental deposits; medium to coarse grained sand, greyish black carbonaceous clay, lignite bands.
103.63 to 178.30m	Essentially marine sequence; limestones, calcareous clays, sands with intervening thin bands of lignite.
178.30 to 211.53m	Continental deposits; medium to coarse grained sandstone, interbedded with grey to black and white clay and pockets of lignite.
211.53 to 274.31m	Kaolinitic clay, very coarse to medium grained sands, biotite flakes, hornblende, weathered basement.

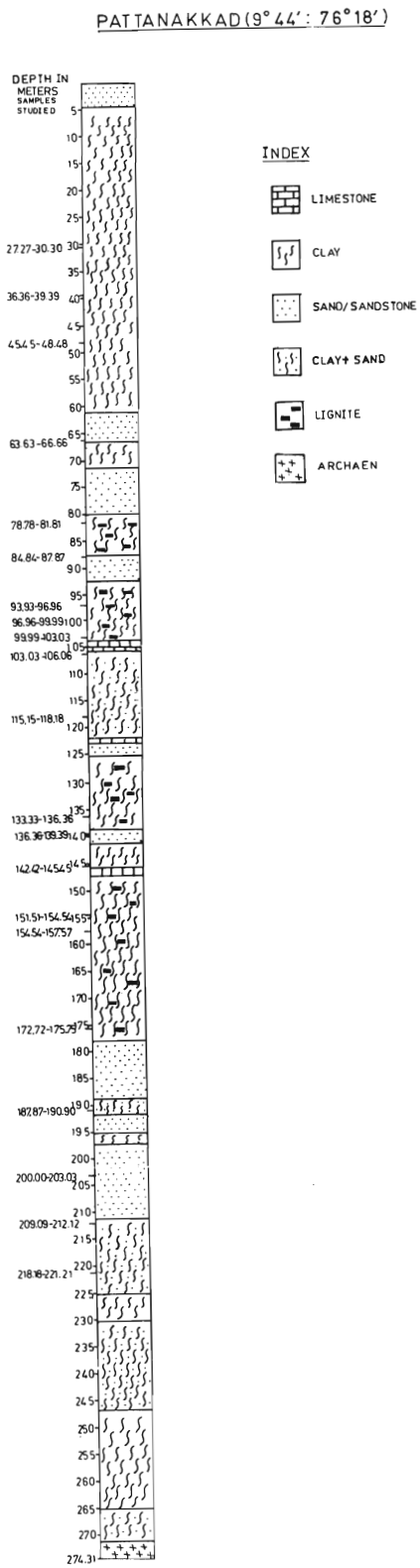

Fig. 1. Lithological Log pertaining to the samples studied.

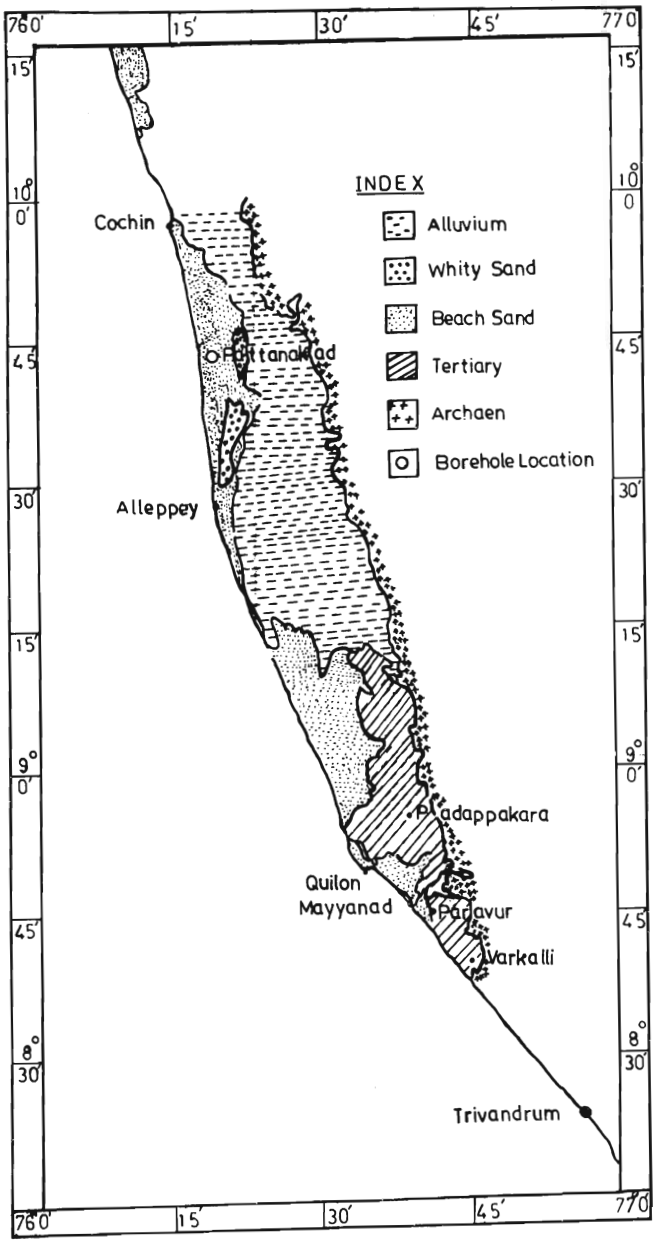

Fig. 2. Geological map of part of Kerala coast showing location of borehole studied (After Poulose *et al*; 1964-66).

Samples of carbonaceous clay, calcareous clay and lignite have yielded well preserved and varied spore and pollen taxa. Traditional methods of maceration involving acid and alkali phases were employed for the recovery of palynoassemblages. Heavy liquid treatment using a mixture of Cadmium Iodide and Potssium Iodide was employed for the concentration of palynofossils for all such samples which were found to be somewhat poor in palynoflora. All the permanent slide preparations and unused palynosamples have been deposited in the Palaeobotany-Palynology Laboratory of the Department of Botany, Post

Graduate College of Science, Osmania University, Saifabad, Hyderabad.

PALYNOASSEMBLAGE : FLORISTIC AND PALAEOENVIRONMENTAL CONSIDERATIONS

The spore and pollen complex of the subsurface Tertiary strata of the Pattanakad borewell consists of myriad pteridophytic and angiospermic elements. The authors· have not encountered gymnospermous palynomorphs in any of the samples studied. A number of fungal fruit bodies and sporomorphs, however, were found along with the palynomorphs. A detailed study of the fungal remains will be dealt with elsewhere.

The Table 1 records the check list of all the identified spore and pollen taxa recovered in the present study along with their affinities with modern taxa.

The total palynoflora recovered comprises of 50 genera and 52 species. The pollen types referable to the dicotyledons of Angiosperms represent the bulk of the palynoflora. The following are numerically the top ten families viz., Arecaceae, Polypodiaceae, Sapotaceae, Schizaeaceae, Caesalpiniaceae, Avicenniaceae, Ctenolophonaceae, Anacardiaceae, Clusiaceae and Bombacaceae. Almost all the spore and pollen taxa recovered from the Pattanakad borewell have been earlier recorded from the outcrops of the Quilon and Warkalli beds (Rao and Ramanujam, 1978, 1982; Ramanujam and Rao, 1973; Ramanujam, 1987).

The totality of the information available highlights a coastal to near coastal vegetational complex comprising typically mangrove scenario with marine nfluence towards the coast and non-mangrove tropical moist vegetation away from the coast. The recognition of spore and pollen types referable to Schizaeaceae, Polypodiaceae, Adiantaceae, Arecaceae, Sonneratiaceae, Rhizophoraceae, Bombacaceae, Avicenniaceae, Sapotaceae, Clusiaceae, Anacardiaceae, Caesalpiniaceae, Combretaceae, Ctenolophonaceae and Olacaceae clearly support the above observation. The common occurrence of ferns of Schizaeaceae and Polypodiaceae and the record of pollen referable to

Table 1. Showing the check list of spore and pollen taxa.

Name of the Taxon	Affinities with modern taxa
PTERIDOPHYTES	
Lygodiumsporites padappakkarensis	Schizaeaceae (Lygodium)
Crassoretitriletes vanraadshooveni	Schizaeaceae (*Lygodium*)
Pteridacidites africanus	Adiantaceae
Lycopodiumsporites sp.	Lycopodiaceae (*Lycopodium*)
Foveotriletes sp.	Lycopodiaceae
Striatriletes susannae	Parkeriaceae (*Ceratopteris*)
Laevigatosporites ovatus	Polypodiaceae
Polypodiisporites impariter	Polypodiaceae
P. turbinatus	Polypodiaceae
P. ratnami	Polypodiaceae
P. perverrucatus	Polypodiaceae
Neyvelisporites bolkhovitinai	Schizaeaceae (*Schizaea*)
Schizaeoisporites grandiformis	Schizaeaceae (*Schizaea*)
S. multistriatus	Schizaeaceae (*Schizaea*)
ANGIOSPERMS	
Retipilonapites tertiaris	Potamogetonaceae (*Potamogeton*)
Palmaepollenites neyveliensis	Arecaceae
P. eocinicus	Arecaceae
Longapertites hammenii	Arecaceae
Paravuripollis mulleri	Arecaceae (*Salacca*)
Quilonipollenites sahnii	Arecaceae (*Eugeissona*)
Q. ornatus	Arecaceae (*Eugeissona*)
Dicolpopollis microreticulatus	Arecaceae (*Calamus*)

Name of the Taxon	Affinities with modern taxa
D. elegans	Arecaceae (*Calamus*)
Trichotomosulcites sp.	Arecaceae
Ctenolophonidites costatus	Ctenolophonaceae (*Ctenolophon*)
Retistephanocolpites neogenicus	Labiatae
Neyvelipollenites sp.	Utriculariaceae (*Utricularia*)
Meliapollis quilonensis	Meliaceae
Compositoipollenites argutus	Asteraceae
Lacrimapollis pilosus	Teliaceae (*Brownlowia*)
Lakiapollis ovatus	Bombacaceae (*Cullinia/Durio*)
Zonocostites ramonae	Rhizophoraceae (*Rhizophora/Bruguier*
	Rubiaceae (*Coprosma*)
Palaeocoprosmadites keralensis	Lecythidaceae (*Barringtonia*)
Marginipollis kutchensis	Hippocrateaceae
Hippocrateaceaedites keralensis	Caesalpiniaceae (*Caesalpinia*)
Margocolporites tsukadai	Caesalpiniaceae (*Caesalpinia*)
M. oligobrochatus	Combretaceae (*Lumnitzera*)
Heterocolpites combretoides	Unknown
Baksipollis miocenicus	Anacardiaceae (*Melanorrhea*)
Rhoipites anacardioides	Avicenniaceae (*Avicennia*)
Retitricolporites sitholeyi	Euphorbiaceae (*Alchorhea*)
Psilatricolporites operculatus	Sapotaceae (*Manilkara*)
Sapotaceoidaepollenites neyveliensis	Sapotaceae
S. africanus	Sapotaceae
S. keralensis	Polygalaceae
Polygalacidites sp.	Clusiaceae (*Symphonia*)
Pachydermites sp.	Unknown
Thomsonipollis sp.	Moraceae (*Artocarpus*)
Triporopollenites minutus	Sonneratiaceae (*Sonneratia*)
Florschuetzia levipoli	Rubiaceae
Cricotriporites camerouensis	Rubiaceae (*Randia*)
Retitriporites quilonensis	Unknown
Subtriporopollis rotundus	Sonneratiaceae (*Duabanga*)
Verrutriporites perverrucatus	Haloragaceae (*Myriophyllum*)
Haloragacidites myriophylloides	Olacaceae (*Anacolosa*)
Anacolosidites luteoides	Thymeliaceae (*Wikstroemia*)
Clavaperiporites jacobi	Droseraceae (*Drosera*)
Ornatetradites droseroides	Unknown
Grimsdalea sp.	

Ctenolophon (Ctenolophonidites) of Ctenolophonaceae, *Anacolosa (Anacolosidites)* of Olacaceae, *Duabanga* of Sonneratiaceae *(Verrutriporites perverrucatus), Symphonia (Pachydermites)* of Clusiaceae, *Alchornea (Psilatricolporites operculatus)* of Euphoriaceae unequivocally point towards heavy precipitation. The epphyllous fungi viz., *Parmathyrites, Trichothyrites,* and *Callimothallus* recorded by us along with spore and pollen complex fully substantiate this contention. The record of pollentypes affiliated to *Rhizophora (Zonocostites), Brownlowia (Lacrimapollis), Sonneratia (Florschuetzia), Avicennia (Retitricolporites sp.), Lakiapollis (Cullinia)* and Lumnitzera *(Heterocolpites)* amply bears testimony to the prevalence of mangrove swamps.

Plate I, figs. 1- 35 illustrate some of the more prominent spore and pollen types recovered in the present study.

SIGNIFICANT SPORE AND POLLEN TAXA OF TERRIGENOUS AND MARINE FORMATIONS AND GEOLOGICAL AGE

As has already been mentioned earlier, both the terrigenous and marine sequences of the subsurface Tertiary deposits have yielded considerably rich palynosuits. And the palynomorphs both at the generic and specific levels recovered from the Ambalapuzha, Quilon and Mayyanad Formations encountered in the Pattanakad borewell are more or less of the same type. Palm pollen types seem to be quantitatively better represented in the Quilon Formation than in the other two formations. There is, however, no qualitative difference betweenthe spore and pollen complexes of these three formations. This clearly indicates the prevalence of uniform floristic communities at the time of deposition of the lithic units of these formations. In other words, the Ambalapuzha, Quilon and Mayyanad Formations, despite representing the by-products of two different facies phenomena, spanned the same geological time (Ramanujam, 1982, 1987).

We consider the following spore and pollen taxa as stratigraphically important elements viz., *Polypodiisporites (abundantly), Striatriletes, Crassoretitriletes, Pteridacidites, Quilonipollenites, Compositoipollenites, Lacrimapollis, Pachydermites, Grimsdalea, Retitriporites, Ornatetradites, Bombacacidites and Polygonacidites*. If these palynomorphs are taken in conjunction with the common occurrence of Sapotaceae, and Caesalpiniaceae, it would then become clear that the Tertiary formations encountered in the Pattanakad borewell could be assignable to the Early Miocene age. *Striatriletes*, though appearing in Middle Eocene becomes widespread and more frequent during Oligocene-Miocene. In the Kerala Neogene sediments (both outcrops and subcrops) *Striatriletes* is generally poorly represented. In the Neogene of Cauvery basin (Venkatachala and Rawat, 1973), Meghalaya and

Table 2. Showing distribution of palynoassemblage

Depth range in meters	Major lithology	Formation	Palynoassemblage (Significant taxa)	Geological horizon
G.L. to 60.90 M	Fine to medium grained sand, greyish white clay, bluish grey clay.	Vembanad Fm.	——	Quaternary to Holocene
60.90 to 103.63 M	Continental sequence, medium to coarse grained sand, greyish black clay, lignite bands.	Ambalapuzha Fm.	Lygodiumsporites, Crassoretitriletes, Pteridacidites, Striatriletes, Polypodiisporites, Neyvelisporites, Schizaeoisporites, Quilonipollenites, Retipilonapites, Ctenolophonidites, Retitricolporites, Palaeocoprosmadites, Compositoipollenites, Sapotaceoidaepollenites, Bombacacidites, Margocolporites, Anacolosidites, Florschuetzia, Cricotriporites, Polygonacidites, Clavaperiporites, Ornatetradites.	Early Miocene
103.63 to 178.30 M	Essentially marine sequence limestone, calcareus clays, sands, with intervening thin lignite bands locally.	Quilon Fm.	Crassoretitriletes, Pteridacidites, Polypodiisporites, Neyvelisporites, Quilonipollenites, Palmaepollenites, Paravuripollis, Longapertites, Dicolpopollis, Retitricolporites, Ctenolophonidites, Zonocostites, Bombacacidites, Compositoipollenites, Florschuetzia, Clavaperiporites, Ornatetradites.	
178.30 to 211.53 M	Continental sequence, coarse to medium grained sandstones with interbedded grey to black and white clay and lignite.	Mayyanad Fm.	Palynoflora exactly similar to that in Ambalapuzha Fm. (60.90 to 103.63 M).	
211.53 to 274.31 M	Kaolinitic clays, coarse to medium graine sands, biotite flakes, hornblende.		Weathered Archaean Basement	

Assam (Rao and Singh, 1986), and Kutch (Kar, 1985) this sporomorph is fairly well represented. *Bombacacidites* is confined to Oligocene in Kutch (Kar, 1985) but extends to Middle to Upper Miocene in the Cauvery basin (Venkatachala and Rawat, 1973). Raha, Rajendran and Kar (1987) state that *Bombacacidits* makes its appearance in India during Oligocene but is also found in Miocene. In a recent study Raha, Rajendran and Kar (1987) recorded frequently *Lygodiumsporites, Quilonipollenites, Lakiapollis, Retitrescolpites, Ctenolophonidites, Triporopollenites* and *Malvacearumpollis* in the subsurface Miocene sediments of Ambalapuzha borewell in Kerala. Many of the above taxa, it is pertinent to note, are also recorded in the present study. It is equally relevant to note that important Eocene taxa such as *Pelliceroipollis, Dandotiaspora, Proxapertites, Meliapollis ramanujami, Palaeosantalaceaepites, Polycolpites, Striacolpites* etc. have not been encountered in the Pattanakad borewell.

Dutta (1981) recently recorded a variety of undoubted Early Miocene (Burdigalean) foraminifera viz., *Miogypsina* (many species), *Lepidocyclina, Austrotrillina* etc. from the marine sequence of the Pattanakad borewell referable to the Quilon Formation. Dutta (1981) further, also suspected a geological horizon underlying the marine Quilon Formation slightly older than Early Miocene on the basis of absence of Early Miocene faunal elements. The plynoassemblage recovered by us from the terrigenous sediments underlying the Quilon Formation of the Pattanakad borewell, however, does not indicate any horizon distinctly older than the Early Miocene.

The following Table 2 provides overall information on the major lithology, lithostratigraphy, significant taxa of the palynoassemblages and the geological age of the Tertiary strata of the Pattanakad borewell.

ACKNOWLEDGEMENTS

The financial assistance provided by the CSIR, New Delhi for the research project, "Palynological and Palaeobotanical studies on the subsurface and surface Tertiary deposits of Kerala State" of which the present work is a part, is gratefully acknowledged. The authors are thankful to the authorities of Central Ground Water Board (CGWB), Kerala Circle, for the supply of the borehole samples.

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EXPLANATION OF PLATES

(Unless otherwise mentioned all Figs. X 1000)

PLATE I

1,2 *Pteridacidites africanus*

3 *Foveotriletes* sp.

4. *Polypodiisporites ornatus*

5. *Striatriletes susannae*

6 *Crassoretitriletes vanroadshooveni*

7-9 *Quilonipollenites sahnii*

10 *Palmaepollenites eocenicus*

11,12 *Margocolporites tsukadai*

13 *Retitricolporites sitholeyi*

14 *Palaeocoprosmadites keralensis*

15 *Haloragacidites myriophyloides*

16 *Sapotaceoidaepollenites neyveliensis*

17 *Haloragacidites* sp.

18 *Sapotaceoidaepollenites africanus*

19,26 *Compositoipollenites argutus*

20 *Gothanipollis indicus*

21,22 *Anacolosidites luteoides*

23,24 *Lacrimapollis pilosus*

25 *Zonocostites ramonae*

27 Baksipollis miocenicus

28,33 *Ctenolophonidites costatus*

29 *Neyvelipollenites* sp.

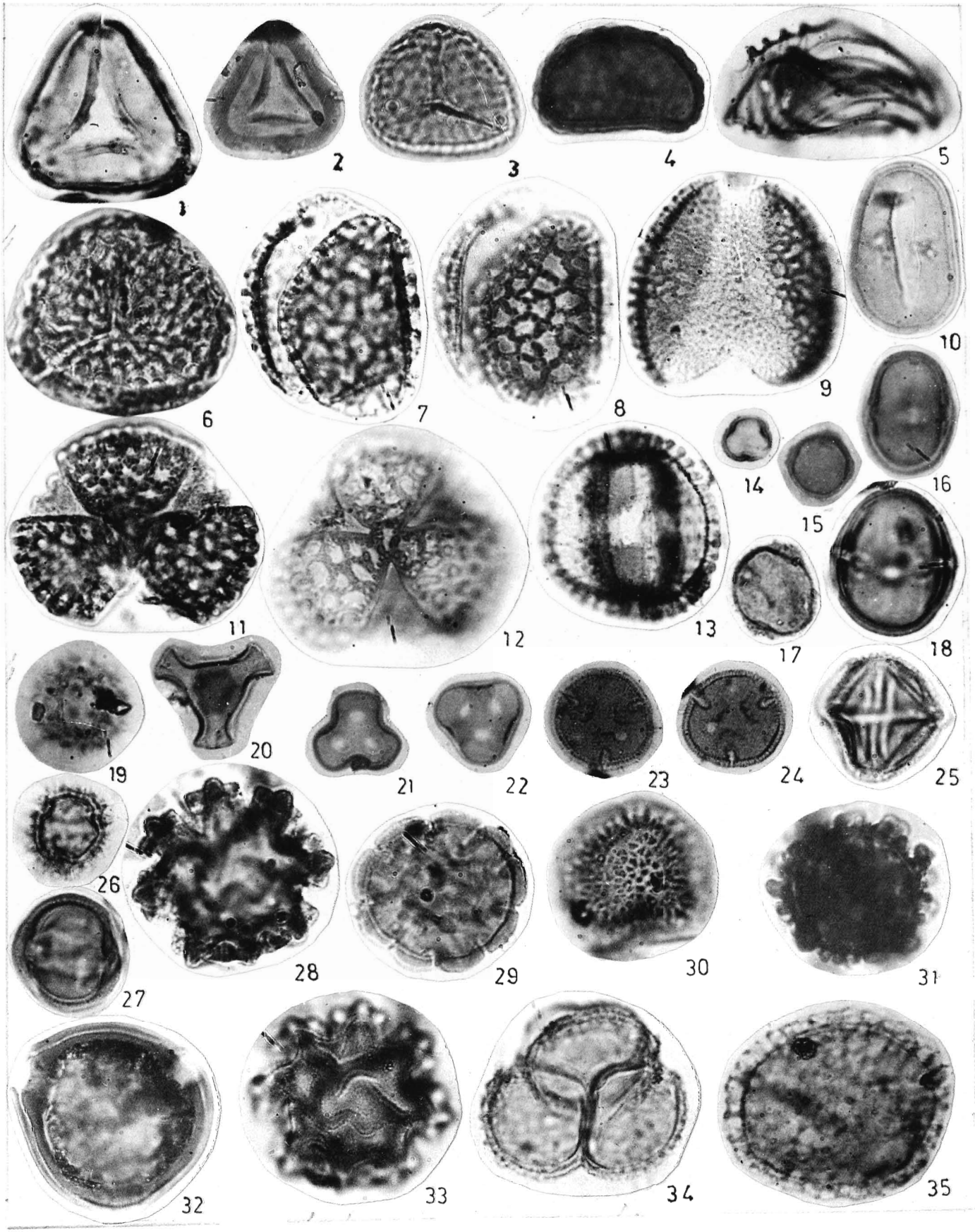
30 *Clavaperiporites jacobi*

31 *Grimsdalea* sp. (x 750)

32 *Pachydermites* sp.

34 *Ornatetradites droseroides* (x 750)

35 *Polygonacidites* sp.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