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EARLY CRETACEOUS DINOFLAGELLATE CYSTS AND MIOSPORES FROM THE MERSA MATRUH 1 BOREHOLE, NORTH WEST DESERT, EGYPT

By

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أحافير الطحالب البحرية والأبواغ وحبوب اللقاح في صخور الطباشيري السفلى - بئر مرسى مطروح ١ الصحراء الغربية - مصر

صلاح يوسف البيلي

تهدف هذه الدراسة إلى التعرف على بعض الأحافير النباتية الدقيقة مثل الطحالب البحرية والأشنات والأبواغ وحبوب اللقاح المتواجدة في صخور الطباشيري السفلى ببئر مرسى مطروح - بالصحراء الغربية المصرية وذلك بغية الوصول إلى تحديد أعمار الطبقات في ذلك التتابع وكذلك الإستدلال على ظروف البيئة القديمة .

وقد تمكن الباحث من تقسيم ذلك التتابع الرسوبي إلى أربع فترات من الأقدم إلى الأحدث كالتالي :

١ - الدورة الترسيبية الأولى من عمق ١٢٢٢٢ قدماً - ١٤٩٢٣ قدماً وعمرها الجيولوجي النيوكومي حتى الباريمي . وقد ترسب ذلك الجزء من التتابع في بدايته تحت ظروف بحرية مفتوحة بينما في جزئه العلوي تحت ظروف بحرية ضحلة .

٢ - الدورة الترسيبية الثانية من عمق ١١٨٢٤ قدماً - ١١٨٣٣ قدماً وعمرها الجيولوجي الباريمي . وقد تراجع البحر بدرجة ملحوظة إبان ترسيب تلك الفترة .

٣ - الدورة الترسيبية الثالثة من عمق ١١١١٩ قدماً - ٩١٨٧ قدماً وتتراوح في عمرها الجيولوجي من الباريمي المتأخر وحتى باكورة العصر الأبتي وقد ترسب ذلك الجزء من التتابع في المنطقة البحرية الضحلة .

٤ - الدورة الترسيبية الرابعة من عمق ٨٨١٠ قدماً - ٥٩٣٦ قدماً وعمرها الجيولوجي يصل إلى الأبتي المتأخر وقد ترسب ذلك الجزء من التتابع وهو أحدثها تحت ظروف قارية وقد استدل على ذلك بكثرة الأبواغ وحبوب اللقاح .

Key Words: Dinoflagellate cysts, Early Cretaceous, Egypt, Mersa Matruh, Miospores.

ABSTRACT

This study aims to document the Neocomian to Aptian palynological assemblages recorded in the Mersa Matruh borehole, north West Desert, Egypt. These palynological assemblages, consisting mainly of dinocysts, miospores and very rare acritarchs are used to interpret four stratigraphic phases of environmental changes in the Early Cretaceous sequence. Phase I from depth 12222 ft to 14923 ft is dated as Neocomian to early Barremian, and is interpreted to have been deposited under fully marine conditions in its basal part and under near-shore marine environment in the Barremian horizon. Phase II at depth 11824 ft - 11833 ft was dated as ? late Barremian. The palynoflora in this horizon suggests a possible regression. The succeeding phase III is dated as late Barremian to early Aptian and is interpreted to have been deposited under inner and middle shelf conditions. The overlying phase IV has been dated as ? late Aptian. Changes in the palynomorph composition in the upper part of phase III within the Matruh Shale and phase IV within the Kharita Member indicate an episode of regression, which is inferred from an increase in the terrestrially-derived palynoflora.

INTRODUCTION

Exploration for fossil hydrocarbons and sedimentary deposits during the sixties and seventies had led to intensive drilling activities in northern Egypt [1]. As a result, thick sequences of subsurface Cretaceous sediments have been discovered. In northern Egypt these are interpreted as marine deposits with minor nonmarine intercalations, but towards the south they become increasingly nonmarine and reach considerable thicknesses. In southern Egypt, research wells for groundwater have contributed significantly to our knowledge of the nonmarine Cretaceous stratigraphy. Subsurface age determinations and facies interpretations have relied mostly on palynology.

The majority of previous pre-Tertiary palynological studies in northern Egypt have primarily concentrated on terrestrially-derived miospores and these have been widely used in palynostratigraphy. Although dinoflagellate cysts occur in some of the northern Egyptian localities [2,3], these have rarely been integrated into the established biostratigraphical framework. Precise age determination by means of these dinocysts was difficult because of the presence of taxa of unknown dating potential. However, it is only recently with the work of the author and his colleagues that an adequate understanding of the Cretaceous dinocyst stratigraphy of Egypt has started to emerge.

This paper is the first attempt to document and present information on the distribution of the organic-walled dinocysts recovered from the Early Cretaceous sediments of the borehole Mersa Matruh 1. The dating of the sequence is based entirely on observations of the spores and pollen grains which have been found associated with cosmopolitan dinocysts [4-10].

STRATIGRAPHIC SETTING

The Early Cretaceous sediments penetrated by the Mersa Matruh 1 have been subdivided from oldest to youngest [6] as follows:

1. Matruh Shale Member : This is composed of dark brown to dark grey, slightly indurated fissile shales with occasional sandy and calcareous interbeds. This unit is limited in distribution to the Matruh area.

The age of this member has been dated as Neocomian to Aptian[4, 11]. The environment of deposition has been interpreted as shallow marine with increasing continental influence towards the top [11].

2. Kharita Member : This member rests conformably on the Matruh Shale Member and consists of fine to coarse quartzose sandstones interbedded with shales and carbonates.

The Kharita Member has been assigned an Aptian [5] to Cenomanian age [11] and is interpreted as having been deposited under marginal deltaic conditions [6].

MATERIALS AND METHODS

The assemblages studied were recovered from core samples of the borehole Mersa Matruh 1, which is situated at 31° 19' 43".00 N and 27° 16' 07".00 E. in the north West Desert of Egypt (Fig.1). The borehole was logged in feet and sample numbers therefore correspond to the original well depths in feet.

Core samples were disaggregated by crushing them in a mortar followed by reaction with concentrated hydrochloric and hydrofluoric acids in order to dissolve carbonates and silicates respectively. After neutralizing the solution in distilled water, the kerogen residue was separated from the inorganic material by sieving through a 10 µm sieve. The organic fraction was subsequently oxidized in Schulze's solution, treated in a 10% solution of NaOH to remove the oxidized kerogen, stained with Safranin O and mounted in Canada Balsam.

A minimum of two slides were prepared from each sample studied, and 200 specimens were counted from each assemblage. Following this counting, the remaining slide was scanned under a 100 oil immersion objective to establish the presence of uncommon species. The exact position of specimens has been determined by use of an England Finder slide (Graticules Ltd.).

The specimens illustrated on figures 4 and 5 and the samples and slides from the study are stored at the Geology Department, Faculty of Science, Qatar University, Doha, Qatar, Arabian Gulf.

PALYNOSTRATIGRAPHIC RESULTS

Twenty-two conventional core samples were studied from the Mersa Matruh-1 borehole. Miospores dominate the majority of assemblages. Due to the presence of Early Cretaceous palynomorph markers in this section, Penny [4] subdivided the sequence into a number of biostratigraphical intervals, ranging from Neocomian to Aptian in age. These can be correlated with the plant microfossil zones 2a, 2b and 3 recently established for Egypt and northern Sudan [12]. In the present study, dinoflagellate cysts provide stratigraphic utility in some horizons, so a more balanced dinocyst/miospore scheme can be applied. The general distribution pattern of stratigraphically important dinocysts and miospores in the Early Cretaceous sequence of the Mersa Matruh 1 well is shown in Fig.2 and their frequency distribution is shown in Table 1. Their significance within the successive phases I-IV is discussed below.

Phase 1 : The oldest part of the sequence studied from the interval between samples 41-34 contained rare dinocysts of little stratigraphic utility. Rare and poorly preserved *Dicheiropollis,* a Neocomian to Barremian guide form in northern Gondwana and Italy, was identified in the present study. It has been previously recorded by Penny [4] and Sultan

[13] from northern Egypt. Additional records of this taxon were also found in Sudan and Northeast Libya [14-16].

Accordingly, samples 41-34 from depth 12222 ft to 14923 ft have been dated as Neocomian to early Barremian.

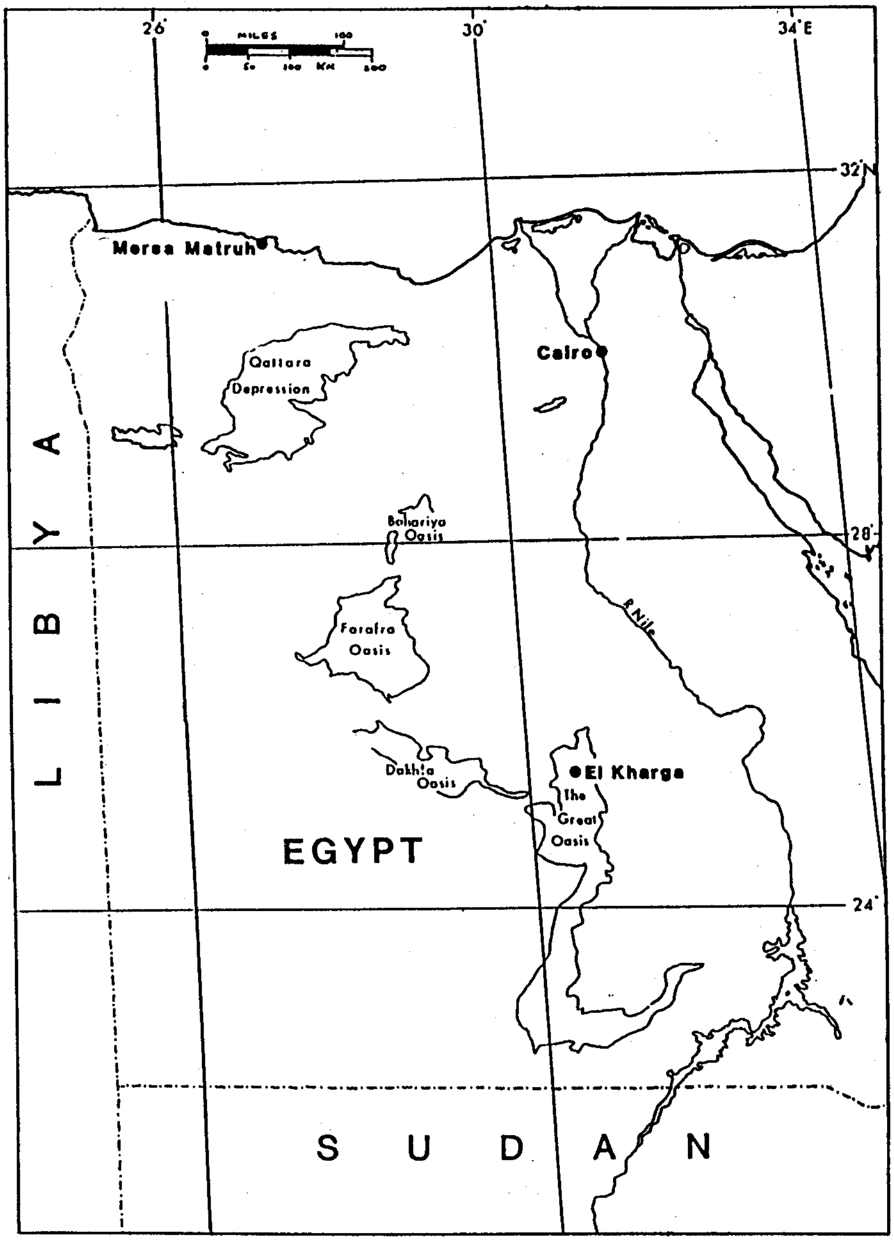

Fig. 1: Map showing the location of the Mersa Matruh-1 well.

Phase II : This phase is characterized by the first appearance of the angiosperm pollen *Stellatopollis bituberensis* Penny,1986, *S. hughesii* Penny,1986, *Retimonocolpites muristriatus* Penny, 1986, *R. muriundulatus* Penny, 1986, *R. matruhensis* Penny, 1986 and *Liliacidites aegyptiacus* Penny, 1986. Dinocysts and acritarchs present include *Escharisphaeridia pocockii* (Sarjeant) Erkmen & Sarjeant, 1980, *Spiniferites* sp., *Oligosphaeridium complex* (White) Davey & Williams,1966 and the acanthomorph acritarch *Micrhystridium* sp.. Foraminiferal test linings are also present.

No age diagnostic dinocysts are present in phase II, however sample 33 (11824-11833 ft) was dated as ? late Barremian [4] based on the angiosperm pollen which account for 6.5% of the land derived palynoflora. Penny [4] also suggested that a possible unconformity or regression is present between samples 34 and 33.

Phase III : This phase is characterized by an upward increase in abundance and diversity of dinocysts. These include chorate dinocysts represented by *Oligosphaeridium complex, O. pulcherrimum* (Deflandre & Cookson) Davey & Williams, 1966, *O. irregulare* (Pocock) Davey & Williams, 1966 and *Spiniferites* sp. Other important taxa in this phase include *Cribroperidinium* sp., *Cyclonephelium* spp., *Coronifera oceanica* Cookson & Eisenack emend. May, 1980, *Pseudoceratium anaphrissa* (Sarjeant) Harding, 1990 and *P. securigerum* (Davey & Verdier) Bint, 1986. Microforaminifera test linings dominate the palynoassemblage. A single specimen of *Muderongia pariata* Duxbury emend. Monteil, 1991 was recorded. The miospore genus *Afropollis* has its stratigraphic base within this interval, which is further

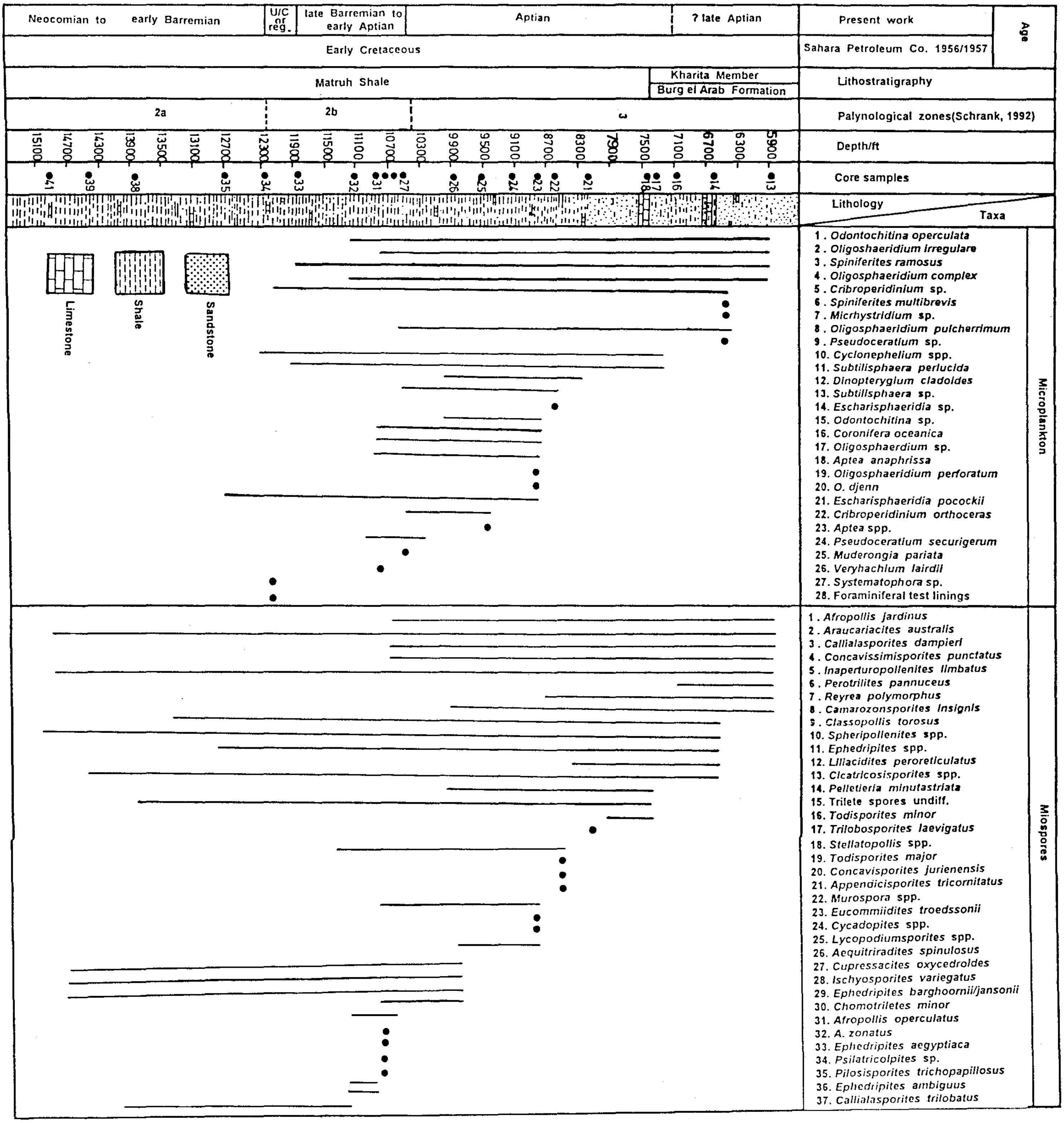

Fig. 2: Distribution of selected palynomorphs in the Neocomian to Aptian sediments of the Mersa Matruh-1 well.

Table 1

Numerical abundances of palynomorphs in the Mersa Matruh - 1 well

Dinocysts and acritarchs

7,412-8'	7,314-7'	7,067-70'	6,577-80	5,900-3'	
•	•	•	X	•	*Caddasphaera halosa*
•	•	•	•	•	Chorate cysts undiff.
•	X	•	•	•	*Cyclonephellum* spp.
•	•	•	•	•	*Escharisphaeridia pocockii*
X	•	O	•	O	Leiospheres
•	•	•	•	•	*Odontochitina ancala*
•	•	•	•	O	*Odontochitina operculata*
•	•	O	•	O	*Oligosphaeridium irregulare*
•	•	*	•	*	*Oligosphaeridium* spp.
X	X	*	•	*	Proximate cysts undiff.
•	•	X	•	X	*Spiniferites ramosus*
•	•	X	•	O	*Subtilisphaera* spp.
•	•	•	•	*	*Trichodinium castanea*
•	•	•	•	•	*Cribroperidinium orthoceras*
•	•	•	•	•	*Cribroperidinium* sp.
•	•	•	•	•	*Fromea amphora*
•	X	O	•	X	Microforaminiferal test linings
•	•	X	•	*	*Oligosphaeridium complex*
•	•	X	•	X	*Oligosphaeridium poculum*
•	•	•	•	O	*Oligosphaeridium porosum*
•	•	•	•	•	*Cleistosphaeridium* spp.
•	•	•	•	•	*Florentinia* spp.
•	•	•	•	•	*Cribroperidinium edwardsii*
•	•	•	•	•	*Oligosphaeridium djenn*
•	•	•	•	•	*Cyclonephelium vannophorum*
•	•	•	•	•	*Coronifera oceanica*
•	•	•	•	•	*Dinopterygium cladoides*
•	•	•	•	•	*Oligosphaeridium pulcherrimum*
•	O	•	•	•	*Subtilisphaera perlucida*
•	•	•	X	•	Scolecodonts
•	•	•	•	•	*Pseudoceratium anaphrissa*
•	•	•	•	•	*Dinopterygium/Xiphophoridium* spp.
•	•	•	•	•	*Pseudoceratium securigerum*
•	•	•	•	•	*Sentusidinium* spp.
•	•	•	•	•	*Pseudoceratium* spp.
•	•	X	•	•	*Odontochitina rhakodes*
•	•	•	•	•	*Aptea/Pseudoceratium* spp.

Dinocysts and acritarchs

9,176-82'	8,812-15'	8,583-6'	8,192-5'	
•	•	•	•	*Pseudoceratium anaphrissa*
O	X	•	•	Chorate cysts undiff.
O	•	•	•	*Cribroperidinium* sp.
•	•	•	•	*Florentinia* spp.
*	*	•	O	Leiospheres
*	*	X	O	Proximate cysts undiff.
O	*	•	*	*Subtilisphaera perlucida*
•	X	*	O	*Subtilisphaera* spp.
X	•	•	•	Microforaminiferal test linings
O	O	•	•	*Caddasphaera halosa*
O	X	O	X	*Oligosphaeridium complex*
O	•	•	•	*Spiniferites ramosus*
•	•	•	•	*Cleistosphaeridium* cf. *ancoriferum*
X	X	X	•	*Odontochitina operculata*
•	•	•	•	*Pseudoceratium* spp.
X	X	•	•	*Cleistosphaeridium* spp.
X	•	•	•	*Coronifera oceanica*
•	O	O	O	*Oligosphaeridium* spp.
•	•	•	•	Scolecodonts
•	•	•	•	*Trichodinium castanea*
•	•	•	X	*Oligosphaeridium* cf. *perforatum*
X	•	•	X	*Oligosphaeridium djenn*
•	•	•	•	Acanthomorphic acritarchs undiff.
X	•	•	•	*Pareodinia ceratophora*
O	•	•	•	*Oligosphaeridium irregulare*
*	X	•	•	*Cyclonephelium* spp.
X	•	•	•	*Escharisphaeridia pocockii*
•	•	•	•	*Subtilisphaera cheit*
•	•	•	•	*Gonyaulacysta* spp.
•	•	•	•	*Microdinium opacum*
*	X	•	•	*Canningia* spp.

Table 1. Contd.

•	X	•	•	*Gonyaulacytsa helicoidea*
O	•	•	•	*Sentusidinium* spp.
•	•	•	•	*Veryhachium lairdii*
•	•	•	•	*Dinopterygium cladoides*
•	•	•	•	*Occisucysta* spp.
•	•	•	•	*Pareodinia* spp.
X	•	•	•	*Microdinium* spp.
O	•	•	•	*Oligosphaeridium dividuum*
O	•	•	•	*Oligosphaeridium poculum*
O	•	•	•	*Oligosphaeridium pulcherrimum*
O	•	•	•	aff. *Dinopterygium cladoides*
•	•	•	•	*Fromea* sp.

Dinocysts and acritarchs

11,119-31'	10,598-610'	10,470-81'	9,862-7'	
•	•	•	•	*Aptea* spp.
*	*	O	•	*Cribroperidinium* sp.
X	X	X	•	*Cyclonephelium* spp.
•	•	•	X	*Dapsilidinium multispinosum*
X	O	•	•	*Qligosphaeridium complex*
*	●	O	*	*Oligosphaeridium* spp.
X	•	X	•	*Pareodinia ceratophora*
X	●	*	*	Proximate cysts undiff.
O	•	•	O	*Spiniferites ramosus*
•	•	•	•	*Subtilisphaera cheit*
*	*	●	●	*Subtilisphaera perlucida*
•	•	•	•	*Trichodinium castanea*
•	•	O	•	*Canningia* spp.
•	X	O	O	Chorate cysts undiff.
•	•	•	•	*Kiokansium polypes*
■	•	•	●	Microforaminiferal test linings
X	•	•	X	*Odontochitina operculata*
•	•	•	•	*Oligosphaeridium irregulare*
•	•	•	•	*Pareodinia* spp.
X	•	•	•	*Pseudoceratium anaphrissa*
•	O	•	•	*Caddasphaera halosa*
•	•	•	•	*Cyclonephelium vannophorum*
•	•	•	•	*Dinopterygium cladoides*
X	•	•	•	*Gonyaulacytsa helicoidea*
•	X	O	•	Leiospheres
X	•	•	X	*Oligosphaeridium dividuum*
X	*	•	•	*Veryhachium lairdii*
•	•	•	•	*Oligosphaeridium poculum*
•	•	•	•	*Oligosphaeridium pulcherrimum*
•	•	X	O	*Cleistosphaeridium* spp.
•	*	•	X	*Florentinia* spp.
•	•	•	X	*Hystrichodinium pulchrum*
•	•	•	O	aff. *Dinopterygium cladoides*
X	•	•	•	*Coronifera oceanica*
X	X	•	•	*Escharisphaeridia pocockii*
•	•	•	•	*Gonyaulacysta* spp.
•	•	•	•	*Odontochitina/Muderongia* spp.
•	•	•	•	*Oligosphaeridium porosum*
•	•	•	•	Scolecodonts
•	•	X	•	Acanthomorphic acritarchs undiff.
•	•	?	•	*Palaeoperidinium cretaceum*
•	X	•	•	*Pseudoceratium regium*
X	O	•	•	*Pseudoceratium securigerum*
•	O	•	•	*Pseudoceratium* spp.
•	X	•	•	*Sentusidinium* spp.
•	X	•	•	*Subtilisphaera terrula*
X	•	•	•	*Exochosphaeridium* spp.
X	•	•	•	*Muderongia staurota*
•	•	•	•	*Veryhachium reductum*
•	•	•	•	*Muderongia extensiva*
•	•	•	•	*Muderongia pariata*
•	•	•	•	*Pterospermella* spp.
•	•	•	•	*Muderongia "matruhii"*
X	•	•	•	*Muderongia* spp.
X	•	•	•	*Microdinium opacum*
•	•	•	•	*Dingodinium albertii*
•	•	•	•	*Muderongia simplex* subsp. *microperforata*

Table 1. Contd.

Dinocysts and acritarchs

12,677-80'	12,220-3'	11,827-33'	
•	•	O	Acanthomorphic acritarchs undiff.
•	•	•	*Pseudoceratium anaphrissa*
•	X	X	Chorate cysts undiff.
•	X	O	*Cribroperidinium* sp.
•	O	*	*Cyclonephelium* spp.
•	•	•	*Escharisphaeridia pocockii*
•	•	•	*Exochosphaeridium* spp.
•	•	•	*Florentinia* spp.
•	•	X	*Gonyaulacytsa helicoidea*
•	•	•	*Kiokansium polypes*
O	*	*	Microforaminiferal test linings
•	•	•	*Muderongia "matruhii"*
•	•	•	*Muderongia simplex*
•	X	•	*Muderongia* spp.
•	•	•	*Oligosphaeridium complex*
•	•	O	*Oligosphaeridium dividuum*
•	•	•	*Oligosphaeridium* spp.
X	*	•	Proximate cysts undiff.
•	•	*	*Subtilisphaera perlucida*
•	•	•	*Systematophora* spp.
•	•	•	*Veryhachium lairdii*
•	•	•	*Dingodinium albertii*
•	•	X	*Dissiliodinium* spp.
•	•	•	*Kleithriasphaeridium simplicispinum*
•	X	•	Leiospheres
•	•	O	*Muderongia simplex* subsp. *microperforata*
•	•	•	*Muderongia staurota*
•	•	•	*Odontochitina operculata*
•	O	X	*Phoberocysta neocomica*
•	•	•	*Pseudoceratium pelliferum*
•	•	•	*Cleistosphaeridium* spp.
•	•	•	*Oligosphaeridium pulcherrimum*
•	•	•	*Pseudoceratium securigerum*
•	•	•	aff. *Subtilisphaera* spp.
•	•	X	*Dapsilidinium multispninosum*
•	•	X	*Hystrichodinium pulchrum*
•	•	X	*Hystrichosphaerina* spp.
•	•	O	*Micrhystridium* spp.
•	•	X	*Occisucysta* spp.
•	O	O	*Sentusidinium* spp.
•	•	X	aff. *Horologinella* spp.
•	•	•	*Caddasphaera halosa*
•	•	•	*Dichadogonyaulax* spp.
•	•	•	*Mendicodinium groenlandicum*
•	•	•	*Perisseiasphaeridium* sp. 1
•	•	•	*Pseudoceratium* spp.
•	•	•	*Aptea* spp.
•	•	•	*Australisphaera* sp. 1
•	•	•	*Cymososphaeridium validum*

Dinocysts and acritarchs

14,398-404'	13,812-4'	
•	•	*Dichadogonyaulax* spp.
O	O	Microforaminiferal test linings
•	•	*Muderongia simplex* subsp. *microperforata*
•	•	*Perisseiasphaeridium* sp. 1
•	•	Proximate cysts undiff.
•	•	*Subtilisphaera perlucida*
•	•	*Systematophora* spp.
•	•	*Veryhachium lairdii*
•	•	*Cyclonephelium* spp.
•	•	*Dichadogonyaulax schizoblata*
•	•	Chorate cysts undiff.
•	•	Leiospheres
•	•	*Muderongia* spp.
•	•	Acanthomorphic acritarchs undiff.
•	•	Scolecodonts
•	•	Barren

Table 1. Contd.

Miospores

7,412-8'	7,314-7'	7,067-70,	6,577-80	5,900-3'	
*	●	●	X	●	*Cyathidites*
O	O	*	X	*	*Afropollis jardinus*
*	*	*	•	O	*Araucariacites australis*
X	X	X	•	X	*Callialasporites dampieri*
•	•	•	•	•	*Camarozonosporites insignis*
•	*	O	•	O	*Cicatricosisporites* spp.
O	•	O	*	O	*Classopollis torosus*
X	•	X	•	X	*Concavissimisporites punctatus*
•	•	•	•	•	*Coronatispora valdensis*
•	•	•	•	•	*Ephedripites ambiguus*
X	•	•	•	•	*Ephedripites barghoornii/staplinii*
•	•	•	•	•	*Eucommiidites troedssonii*
O	•	*	O	X	*Gliscopollis meyeriana*
●	●	*	X	●	*Inaperturopollenites limbatus*
•	•	•	•	O	*Leptolepidites* spp.
•	•	•	•	•	*Murospora* spp.
O	*	*	•	•	*Pelletieria minutaestriata*
•	•	X	•	O	*Perotriletes pannuceus*
O	•	•	•	•	Pollen grain (open lattice)
•	•	•	•	?	*Reyrea polymorphus*
*	*	●	O	*	*Spheripollenites* spp.
•	•	•	•	•	*Stellatopollis* spp.
X	X	X	•	•	Trilete miospores undiff.
X	•	•	•	•	aff. *Araucariacites* spp.
•	X	•	•	O	"Small megaspores"
•	•	•	•	•	*Baculatisporites* spp.
O	*	O	•	O	*Botryococcus* spp.
•	•	•	•	•	*Callialasporites turbatus*
•	•	•	•	•	*Densoisporites* spp.
*	X	X	X	O	*Ephedripites* spp.
X	•	•	X	•	*Liliacidites peroreticulatus*
•	•	X	•	•	*Lycopodiumsporites* spp.
•	•	•	•	•	*Schizosporis parvus*
•	•	•	•	•	*Sestrosporites pseudoalveolatus*
•	•	•	•	X	Apiculate miospore cluster
•	•	•	•	X	*Bullasporis aequatorialis*
•	•	•	•	X	Pilate spore (indet.)
•	X	X	•	X	*Rouseisporites reticulatus*
•	•	•	•	•	*Camarozonosporites insignis* sensu Saad
•	•	•	•	•	*Exesipollenites saccatus*
•	•	•	•	•	*Stellatopollis barghoornii/staplinii*
•	•	•	•	•	*Ephedripites jansonii*
•	•	•	•	•	Tectate pollen undiff.
•	•	•	•	•	Apiculate miospores undiff.
•	•	•	•	•	*Classopollis* tetrads
•	X	•	•	•	*Todisporites minor*
•	•	X	X	•	*Celyphus rallus*
•	•	•	•	•	*Gleicheniidites* spp.
O	O	O	•	•	*Pediastrum* spp.

Miospores

9,176-82'	8,812-15'	8,583-6'	8,192-5'	
●	●	●	●	*Cyathidites*
X	X	*	O	*Afropollis jardinus*
●	●	*	●	*Araucariacites australis*
X	•	•	•	*Baculatisporites* spp.
O	O	•	O	*Botryococcus* spp.
X	O	•	•	*Callialasporites dampieri*
•	•	O	•	*Chomotriletes minor*
X	X	X	O	*Cicatricosisporites* spp.
*	•	•	O	*Classopollis torosus*
X	X	•	•	*Concavissimisporites punctatus*
•	•	•	•	*Densoisporites velatus*
X	X	X	O	*Ephedripites* spp.
*	*	*	O	*Gliscopollis meyeriana*
*	*	O	●	*Inaperturopollenites limbatus*
•	X	X	•	*Leptolepidites* spp.
•	•	•	O	*Liliacidites peroreticulatus*
•	X	•	•	*Murospora* spp.
X	O	X	•	*Pediastrum* spp.

Table 1. Contd.

*	•	•	•	*Pelletieria minutaestriata*
•	•	•	•	*Perotriletes* cf. *pannucus*
X	X	•	•	Pollen grain (open lattice)
•	•	•	•	*Retimonocolpites* sp. (small)
X	•	•	•	*Scenedesmus* spp.
*	*	*	O	*Spheripollenites* spp.
•	•	X	•	*Stellatopollis* sp. (primitive form)
•	•	•	•	*Todisporites minor*
X	•	•	•	aff. *Aratrisporites* spp.
•	X	•	•	"Small megaspores"
•	X	•	•	Apiculate miospores undiff.
•	•	•	•	*Camarozonosporites insignis* sensu Saad
•	•	•	•	*Cicatricosisporites angicanalis*
•	X	•	•	*Eucommiidites troedssonii*
•	•	•	•	*Liliacidites peroreticulatus* (clusters)
•	•	•	•	*Perotriletes* spp.
•	•	•	•	*Rouseisporites reticulatus*
•	O	•	•	aff. *Araucariacites* spp.
•	•	X	•	*Bullasporis aequatorialis*
X	X	•	X	*Cupressacites oxycedroides*
•	O	•	X	*Exesipollenites tumulus*
•	•	•	•	*Stellatopollis barghoornii/staplinii*
X	•	X	•	Trilete miospores undiff.
•	•	•	•	*Classopollis* tetrads
•	X	•	•	*Stellatopollis* spp.
•	X	•	•	*Cycadopites* spp.
•	•	•	•	*Brevitricolpites* sp.
•	•	O	•	*Celyphus rallus*
•	X	•	•	*Ephedripites barghoornii/staplinii*
•	•	•	•	*Ephedripites irregularis*
X	X	•	•	*Lycopodiumsporites* spp.
•	•	•	X	Reticulate pollen undiff.

Miospores

11,119-31'	10,598-610'	10,470.81'	9,862-7'	
•	X	•	•	*Cyathidites*
•	X	•	•	"Small megaspores"
X	X	•	•	*Aequitriradites spinulosus*
X	*	O	•	*Afropollis jardinus*
*	*	*	*	*Araucariacites australis*
•	•	O	X	*Botryococcus* spp.
X	X	•	X	*Callialasporites dampieri*
•	X	•	X	*Cicatricosisporites* spp.
•	•	•	O	*Classopollis torosus*
•	•	•	•	*Concavissimisporites punctatus*
O	*	O	X	*Cupressacites oxycedroides*
•	O	X	O	*Ephedripites* spp.
O	*	*	*	*Gliscopollis meyeriana*
•	•	•	•	*Gliscopollis* tetrads
*	*	*	*	*Inaperturopollenites limbatus*
•	•	O	•	*Ischyosporites variegatus*
X	O	•	•	*Murospora* spp.
*	*	•	•	*Pediastrum* spp.
•	O	•	•	*Pelletieria minutaestriata*
•	X	•	•	*Retimonocolpites* spp.
•	*	*	*	*Spheripollenites* spp.
•	•	X	•	Trilete miospores undiff.
•	O	•	•	aff. *Araucariacites* spp.
•	•	•	•	*Baculatisporites* spp.
•	O	•	•	*Lycopodiumsporites* spp.
•	•	X	•	Pollen grain (open lattice)
X	•	•	*	*Stellatopollis* sp. (primitive form)
•	O	•	•	*Afropollis operculatus*
•	O	•	•	*Afropollis zonatus*
•	•	X	•	*Camarozonosporites insignis* sensu Saad
•	•	X	X	*Celyphus rallus*
•	X	•	X	*Exesipollenites tumulus*
•	•	•	•	*Eucommiidites troedssonii*
X	•	•	•	*Rouseisporites reticulatus*
•	•	•	X	*Cerebropollenites mesozoicus*
X	•	X	X	*Ephedripites barghoornii/staplinii*
•	•	•	X	*Perotriletes* cf. *pannuceus*
•	X	•	X	*Schizosporis parvus*

Table 1. Contd.

•	•	X	•	*Chomotriletes minor*
•	•	X	•	*Densoisporites velatus*
•	•	•	•	*Liliacidites peroreticulatus*
•	•	•	•	*Pilosisporites* spp.
O	•	•	•	*Scenedesmus* spp.
•	•	•	•	*Callialasporites turbatus*
•	X	X	•	*Afropollis* sp. (large form)
•	•	•	•	*Densoisporites microrugulatus*
•	•	•	•	*Cycadopites* spp.
•	X	•	•	*Appendicisporites* spp.
X	?	•	•	*Clavatipollenites hughesii*
•	X	•	•	*Ephedripites jansonii*
•	•	•	•	*Liliacidites* spp.
X	•	•	•	*Pilosisporites trichopapillosus*
X	•	•	•	*Ephedripites ambiguus*
•	•	•	•	*Todisporites minor*

Miospores

12,677-80'	12.220-3'	11,827-33'	
●	O	●	*Cyathidites*
•	•	•	*Afropollis jardinus*
*	*	O	*Araucariacites australis*
X	X	•	*Callialasporites turbatus*
X	*	*	*Cupressacites oxycedroides*
•	•	X	*Ephedripites* spp.
●	●	●	*Gliscopollis meyeriana*
*	*	O	*Inaperturopollenites limbatus*
•	•	X	*Pediastrum* spp.
•	•	•	*Pilosisporites* spp.
•	•	•	*Scenedesmus* spp.
*	*	●	*Spheripollenites* spp.
X	O	X	*Callialasporites dampieri*
•	X	X	*Cicatricosisporites* spp.
•	•	•	*Cycadopites* spp.
•	•	•	*Aequitriradites spinulosus*
O	•	•	*Classopollis torosus*
•	•	•	*Coronatispora valdensis*
•	•	•	*Perotriletes* spp.
•	•	•	*Rouseisporites reticulatus*
•	•	X	"pre-*Afropollis*" sp.
•	•	X	Apiculate miospores undiff.
•	•	X	*Callialasporites trilobatus*
•	•	X	*Exesipollenites saccatus*
•	•	X	*Gliscopollis* tetrads
•	•	•	*Afropollis operculatus*
X	•	•	*Celyphus rallus*
•	•	•	Trilete miospores undiff.
•	•	•	*Densoisporites velatus*
•	•	•	*Ischyosporites variegatus*
•	•	•	*Stellatopollis* sp. (primitive form)
•	•	•	*Todisporites minor*
•	X	•	*Dicheiropollis etruscus*
•	•	•	*Camarozonosporites insignis*
•	•	•	*Callialasporites* spp.
•	•	•	*Baculatisporites* spp.
•	•	•	*Chomotriletes minor*
•	•	•	*Contignisporites* spp.
•	•	•	Pollen grain (open lattice)
•	•	•	*Trilobosporites* spp.

Miospores

14,398-404'	13,812-4'	
*	*	Cyathidites
X	*	*Araucariacites australis*
*	•	*Spheripollenites* spp.
•	•	*Todisporites minor*
•	•	*Contignisporites* spp.
•	•	*Cupressacites oxycedroides*
•	•	*Densoisporites* spp.
*	X	*Gliscopollis meyeriana*
?	•	*Aequitriradites spinulosus*
X	•	*Celyphus rallus*
•	•	*Dicheiropollis etruscus*

Table 1. Contd.

X	•	*Inaperturopollenites limbatus*
X	•	*Callialasporites trilobatus*
•	•	Tectate pollen undiff.
•	X	*Callialasporites* spp.
•	X	Trilete miospores undiff.
•	•	*Baculatisporites* spp.
•	•	*Callialasporites turbatus*
•	•	*Chomotrilletes minor*
X	•	*Cicatricosisporites* spp.
•	•	*Contignisporites cooksonii*
•	•	*Eucommiidites troedssonii*
X	•	Apiculate miospores undiff.
•	•	*Callialasporites dampieri*
•	•	*Coronatispora valdensis*
•	•	*Aequitriradites* sp.

Key to Symbols
X = 1 Specimen
O = 2-4 Specimens
* = 5-20 Specimens
● = 21-70 Specimens
■ = 71-100 Specimens
? = Questionably Present
• = Not Present

characterized by localized minor influxes of *Cupressacites oxycedroides* Reyre, 1970 and *Ephedripites* spp. *Aequitriradites* cf. *spinulosus* (Cookson & Dettmann) Cookson & Dettmann, 1961 occurs rarely as do rare specimens of *Pilosisporites trichopapillosus* (Thiergart) Delcourt & Sprumont, 1955 and small megaspores of the genus *Balmeisporites*.

The dinocyst *P. anaphrissa* is known to range from late Hauterivian to late Barremian or ? middle Aptian [17]. In Egypt this species has been identified in Aptian sediments of the Western Desert [18]. *P. securigerum* is generally considered to be good Bedoulian to late Gargasian marker (early to middle Aptian) [3, 19], although it was encountered throughout the Albian DSDP site 402A [20]. *M. pariata* was also recorded from the Aptian-Albian sediments of the Western Desert [3]. *P. anaphrissa and Odontochitina operculata* (Wetzel) Deflandre & Cookson, 1955 are the two most important species in the Barremian. They have worldwide occurrences during this interval. *O. operculata* is an additional diagnostic cosmopolitan species which appears at the Hauterivian/Barremian boundary in widely separated areas.

Afropollis appears in the upper part of the miospore association VI in Northeast Libya [16] of Barremian age. Penny [7] notes the presence of *Afropollis* in independently dated late Barremian from England. This was confirmed by Gübeli et al. [21] who recorded *A. operculatus* Doyle et al., 1982 in their Barremian Zone D in Morocco.

From the evidence cited above, the interval from 11100 - 10825 feet is dated as late Barremian to early Aptian. It is noteworthy to mention that a correlation can be made with subzone B in the northern Negev of Palestine [22].

Phase IV : The highest occurrence of the dinocyst *P. anaphrissa* defines the top of this interval from sample 30 to sample 13. It occurs in low numbers and is associated with a marked increase in numbers of dinocysts. Forms such as *O. pulcherrimum, Cribroperidinium edwardsii* (Cookson & Eisenack) Davey, 1969 are the dominant cyst species associated with influxes of microforaminiferal test linings. *P. Securigerum , O. operculata, O. complex* and *Subtilisphaera perlucida* (Alberti) Jain & Millepied, 1973 occur in lower numbers. Rare components of the miospore assemblage include *Afropollis jardinus* (Brenner) Doyle et al., 1982, *A. operculatus, A. zonatus, Araucariacites australis* Cookson, 1947, *Callialasporites dampieri* (Balme) Sukh Dev, 1961, *Cyathidites* spp., *Ephedripites* spp. *Pelletieria minutaestriata* Bolkhovitina , 1961, *P. trichopapillosus, Reyrea polymorphus* Herngreen, 1973, and *Spheripollenites* spp.

The identification of an *Oligosphaeridium* event in the Aptian part of the marine Matruh Shale in the Mersa Matruh 1 borehole which has been recorded from Association III of middle/late Albian age in Northeast Libya [19] is of interest, as it also appears to be present in both onshore and offshore Morocco [17, 23]. This association consists of palynomorphs which are common in Aptian assemblages elsewhere, including on and offshore Morocco, Northeast Libya, Sudan, France and southern England. Those whose range tops are thought to occur at this stage include *P. anaphrissa* and *R. polymorphus*. The former is an important marker in the *Deflandrea* (now *Subtilisphaera*) *pirnaensis/Tenua* (*P.*) *anaphrissa* Assemblage Zone , of Aptian age, recognized from the Egyptian Western Desert [18]. *R. polymorphus* has a range of late Albian to possibly middle Albian [15, 24, 25]. The age inferred by the presence of these two species in the Mersa Matruh 1 borehole, is therefore, late Aptian. An age younger than lower Albian is precluded by the lack of pollen such as *Elaterosporites, Elaterocolpites, Sofrepites,* and *Galeacornea* typically found in the late Albian/Cenomanian of Egypt [2, 26, 27] and other African countries.

PALAEOENVIRONMENTAL INTERPRETATIONS

Analysis of palaeoenvironmental data from the Mersa Matruh 1 well indicates that the organic particles preserved in the Matruh Shale and the Kharita Member of the Burg el Arab Formation can be classified into groups which reflect depositional facies. The first group includes the organic-walled planktonic fossils (dinocysts, acritarchs, other algae). The second group of organic particles found in these sediments is terrigenous land plant detritus. This kind includes pollen grains, pteridophytic spores, tissues and cellular cuticle, tracheids and inertinite.

The palynomorphs extracted from the Early Cretaceous sediments of the Mersa Matruh 1 well are interpreted as forming four significant environmentally controlled "phases" that provide clues on the development of the marine/nonmarine environment. The differential characters of these phases are primarily based on the presence of selected marine dinocysts and terrestrially derived miospores and pollen grains.

Phase I : This phase ranges from Neocomian to early Barremian age and the dinocysts present are of very low diversity. They are rather poorly preserved and include morphologically unusual forms, possibly as a consequence of environmental changes such as reduced salinities associated with close proximity to the shoreline [4]. In the upper part of phase I, microforaminiferal test linings and *Systematophora* spp. become more common. Their presence was taken to indicate more normal marine conditions.

Phase II : This occurs in sample 33 of late Barremian age. Compared with their scarcity in phase I, dinocyst abundance and species diversity in phase II increase. *Cyclonephelium* spp., *S. perlucida* and foraminiferal test linings are common. The latter forms have been previously considered to inhabit lower salinity, nearshore marine environments [28].

Phase III : This phase ranges from sample 32 to sample 24. It is characterized by high abundance of microforaminiferal test linings, *Oligosphaeridium* spp., *Cribroperidinium* spp., and *A. australis.* Other taxa in phase III include *S. multibrevis, P. securigerum, M. pariata, Subtilisphaera* spp. and *Micrhystridium* spp.

The abundance and diversity of the cysts imply deposition in a marine environment of normal salinity which was sufficiently rich in nutrients to support a varied population of dinoflagellate cysts [19]. The large numbers of terrestrially derived plant debris in some preparations, together with *A. australis,* the presence of several well preserved megaspores in others and the numerous peridinioid cysts of the genus *Subtilisphaera* and foraminiferal test linings in most samples suggest that both inner and middle shelf deposits are represented [19].

Phase IV : This phase ranges from sample 23 to the top of the studied sequence. In this part of the section, dinocyst numbers decrease and terrestrial particles (spores, pollen and woody tissues) become more common. The reduction in the dinocyst representation, associated with the appearance of the abundant terrestrially-derived palynoflora is an indication of change from open marine in the lower part of the Matruh Shale to marginal marine conditions in the upper part of this unit and in the overlying Kharita Member sediments [6, Fig.3].

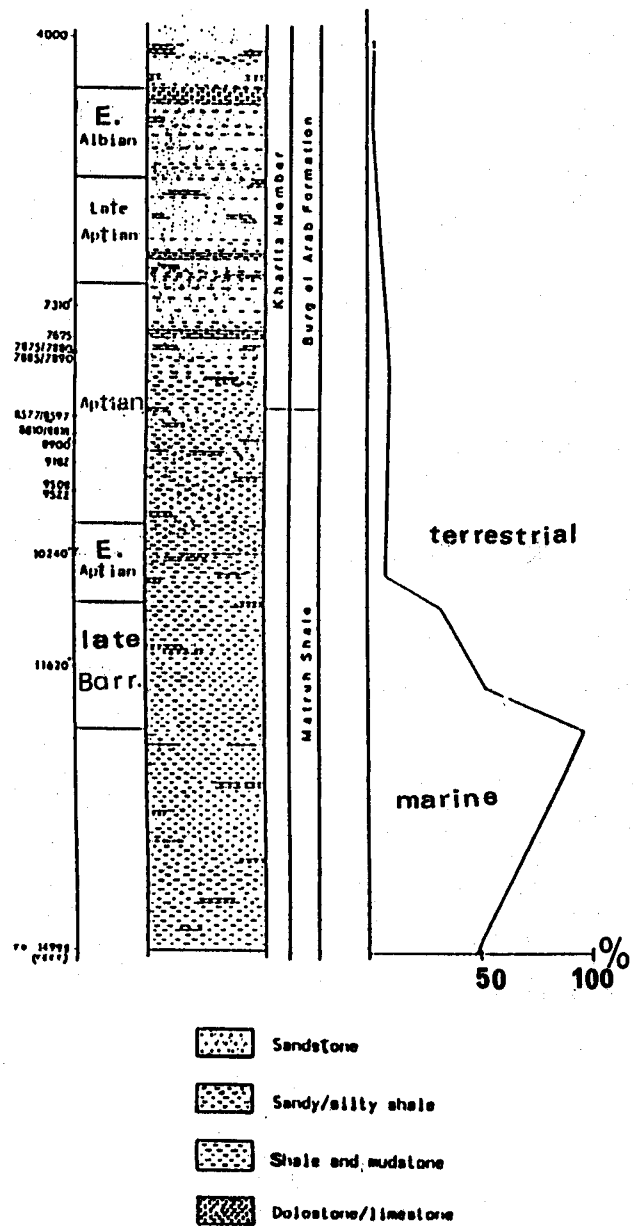

Fig. 3: Stratigraphic log of the Mersa Matruh-1 well showing the changes in lithology and marine: terrestrial palynomorph ratio (Data from Penny [6]).

Further indication of progressively shallower conditions is provided by the gradual increase in the sand and silt content of the shales in this unit and by the greater frequency of sandy interbeds [6].

Plate captions

The sample number and slide designation together with the England Finder reference are given sequentially for each illustrated specimen. A Leitz orthoplan microscope fitted with Nomarski interference contrast illumination (IC) was used for all figures. Magnification is X750 throughout.

Fig. 4

1. Unidentified miospore, c#21A, J28.

2. *Balmeisporites* cf. *auriculatus* HALL sensu SAAD, 1978 C#29B, A34.

3. *Aequitriradites* cf. *spinulosus* (COOKSON and DETT- MANN) COOKSON and DETTMANN, 1961, C#31A, D52.

4, 12. *Ephedripites* sp., C#16A, N44; C#21B, X36.

5. *Camarozonosporites insignis* sensu SAAD, 1978, C#16B, V20.

6. *Deltoidospora* cf. *germanica* Dörhöfer, 1977, C#16B, W43.

7. *Todisporites minor* COUPER, 1958, C#16B, E45.

8, 9. *Afropollis jardinus* (BRENNER) DOYLE *et al.,* 1982, C#16A, X20, G43.

10. ? *Reyrea polymorphus* HERNGREEN, 1973, C#16A, Y42.

11. *Stellatopollis* sp., C#22B, N35.

13. *Appendicisporites tricornitatus* WEYLAND and GREIFELD, 1953, C#22B, F37.

14. *Pilosisporites trichopapillosus* (THIERGART) DELCOURT and SPRUMONT, 1955, C#30B, E46.

15. *Lycopodiumsporites* sp., C#22B, M44.

16. *Murospora florida* BALME, 1957, C#29B, S41.

17. *Afropollis* sp. (large form), C#29B, O32.

18. *Cupressacites oxycedroides* REYRE, 1970, C#30B, M31.

19. *Concavissimisporites* cf. *crassatus* (DELCOURT and SPRUMONT) DELCOURT *et al.,* 1963, C#16A, S48.

20. *Pelletieria minutaestriata* BOLKHOVITINA, 1961, C#21B, R40.

21. ? Cyatheaceous spore type 1 sensu BATTEN and UWINS, 1985, C#16B, H27.

22. *Araucariacites australis* COOKSON, 1947, C#16A, U42.

23. *Ephedripites barghoornii/jansonii* (POCOCK) MULLER, 1968, C#31B, H29.

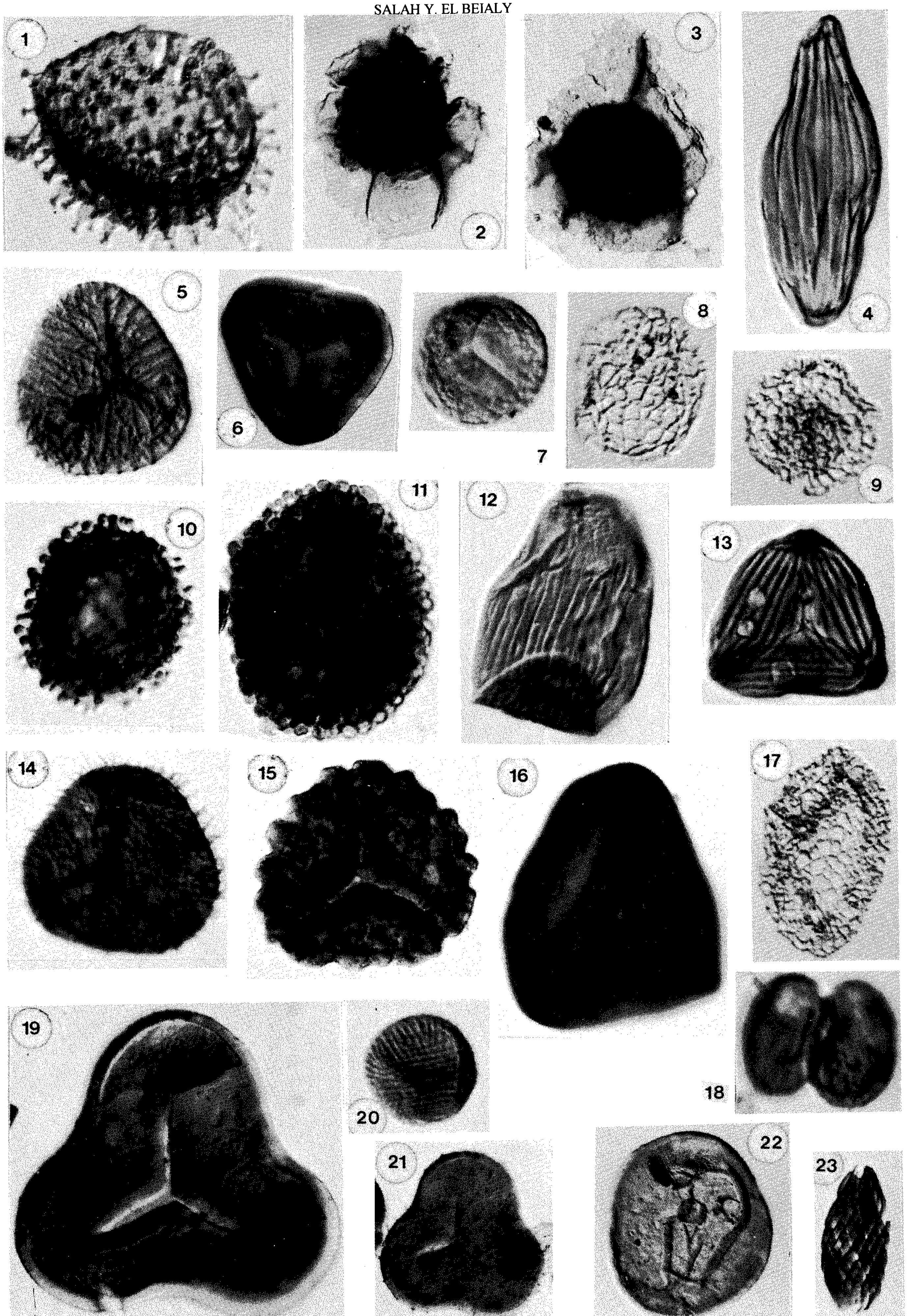

Fig.4.

Fig. 5

1. *Subtilisphaera perlucida* (ALBERTI) JAIN and MILLEPIED, 1973, C#22B, W53.

2. *Cerbia* cf. *tabulata* (DAVEY and VERDIER) BELOW, 1981, C#22A, G53.

3. *Pseudoceratium securigerum* (DAVEY and VERDIER) BINT, 1986 C#31A, H28.

4. *Muderongia pariata* DUXBURY, 1983, C#31B, U17.

5. *Cyclonephelium* cf. *distinctum* DEFLANDRE and COOKSON, 1955, C#33A, S51.

6. *Oligosphaeridium complex* (WHITE) DAVEY and WILLIAMS, 1966, C#31A, O30.

7. *Micrhystridium* sp., C#33A, U24.

8. *Cribroperidinium orthoceras* (EISENACK) DAVEY, 1969, C#29A, B40.

9. *Pseudoceratium anaphrissa* (SARJEANT) HARDING, 1990, C#30A, W42.

10. *Spiniferites multibrevis* (DAVEY and WILLIAMS) BELOW, 1982, C#32A, U43.

11. *Oligosphaeridium* cf. *poculum* JAIN, 1977, C#24A, P46.

12. *Oligosphaeridium pulcherrimum* (DEFLANDRE and COOKSON) DAVEY and WILLIAMS, 1966, C#24A, N39.

13. *Systematophora* sp., C#34A, W45.

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REFERENCES

[1] **El Ayouti, M. K., 1980.** Oil and gas prospects in Egypt. Rev. de l'Institut Francais du Pétrole, 35 : 585-618.

[2] **El Beialy, S. Y., S. N. Ayyad and S. E. Kholeif, 1990.** Mesozoic-Tertiary palynomorphs and planktonic foramin- ifera of the subsurface section of the Sindy 1 well, eastern Nile Delta, Egypt. Newsl. Stratigr., 22 (2/3) :71-85.

[3] **Omran, A. M., H. A. Soliman** and **M. S. Mahmoud, 1990.** Early Cretaceous palynology of three boreholes from northern Western Desert (Egypt). Rev. Palaeobot. Palynol., 66 : 293-312.

[4] **Penny, J. H. J., 1986.** An Early Cretaceous angiosperm pollen assemblage from Egypt. Spec. Pap. Palaeontol., 345: 121-134.

[5] **Penny, J. H. J., 1988a.** Early Cretaceous acolumellate semitectate pollen from Egypt. Palaeontol., 31 : 373-418.

[6] **Penny, J. H. J., 1988b.** Early Cretaceous striate tricolpate pollen from the borehole Mersa Matruh 1, north West Desert, Egypt. J. Micropalaeontol., 7 : 201-215.

[7] **Penny, J. H. J., 1989.** New Early Cretaceous forms of the angiosperm pollen genus *Afropollis* from England and Egypt. Rev. Palaeobot. Palynol., 58 : 289-299.

[8] **Penny, J. H. J., 1991.** Early Cretaceous angiosperm pollen from the borehole Mersa Matruh 1, north West Desert, Egypt. Palaeontogr. Abt. B, 222 : 31-88.

[9] **El Shamaa, A.E., 1988.** Aptian and Albian miozones of the Western Desert, Egypt. 9th Petrol. Conf. Explor. Produc., EGPC : 1-17.

[10] **El Shamaa, A. E.** and **A. A. Arafa, 1990.** Early pollen angiosperms [sic] from the Lower Cretaceous sediments in the northern part of the Western Desert, Egypt. Egyptian J. Geol.32 (for 1988) : 263-272.

[11] **Hantar, G., 1990.** North Western Desert. In: The Geology of Egypt (ed. R. Said) : 293-319 (Balkema, Rotterdam, Brookfield).

[12] **Schrank, E., 1992.** Nonmarine Cretaceous correlations in Egypt and northern Sudan: palynological and palaeobotanical evidence. Cret. Research, 13 : 351-368.

[13] **Sultan, I. Z., 1986.** Palynostratigraphy of Lower Cretaceous sediments in the Nile Delta region, Egypt. Rev. Españ. Micropaleontol., 18 : 55-70.

[14] **Kaska, H. V., 1989.** A spore and pollen zonation of Early Cretaceous to Tertiary nonmarine sediments of central Sudan. Palynol., 13 : 79-90.

[15] **Thusu, B.** and **J. G. L. A. Van der Eem, 1985.** Early Cretaceous (Neocomian-Cenomanian) palynomorphs.J. Micropalaeontol., 4: 131-151.

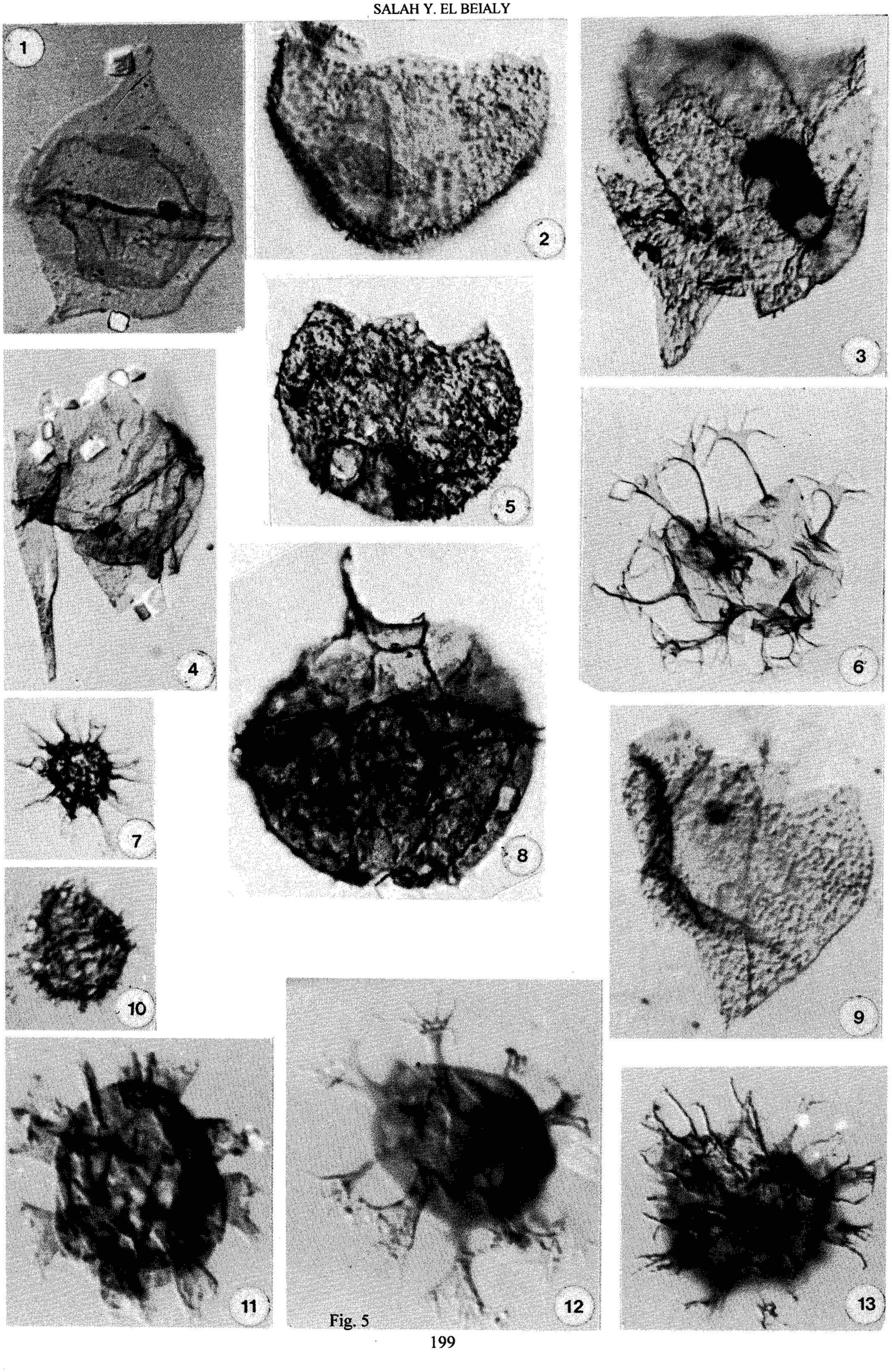

Fig. 5

[16] **Thusu, B., J. G. L. A. Van der Eem, A. El Mehdawi, and F. Bu-Argoub, 1988.** Jurassic-Early Cretaceous palynostratigraphy in Northeast Libya (ed. A. El-Arnauti, B. Owens and B. Thusu) : 171-214 (Garyounis Univ. Publ., Benghazi).

[17] **Below, R., 1982.** Scolochorate Zysten der Gonyaulacaceae (Dinophyceae) aus der Unterkreide Marokkos. Palaeontogr. B, 176:1-145.

[18] **Urban, L. L., L. V. Moore** and **M. L. Allen, 1976.** Palynology, thermal alteration and source rock potential of three wells from Alamein area, Western Desert, Egypt. 5th Egyptian General Petroleum Company Seminar: 1-31.

[19] **Uwins, P. J. R.** and **D. J. Batten, 1988.** Early to mid-Cretaceous palynology of Northeast Libya. In: Subsurface Palynostratigraphy of Northeast Libya (ed. A. El- Arnauti, B. Owens and B. Thusu): 215-257 (Garyounis Univ. Publ., Benghazi).

[20] **Davey, R. J., 1979.** Marine Apto-Albian palynomorphs from Holes 400A and 402A, IPOD Leg 48, northern Bay of Biscay. Init. Repts DSDP, 48 : 547-561.

[21] **Gübeli, A.A., P. A. Hochuli and W. Wildi, 1984.** Lower Cretaceous turbiditic sediments from the Rif Chain (northern Morocco) - palynology, stratigraphy and palaeogeographic setting. Geol. Rdsch., 73 : 1081-1114.

[22] **Brenner, G. J. and I. S. Bickoff, 1992.** Palynology and age of the Lower Cretaceous basal Kurnub from the coastal plain to the northern Negev of Israel. Palynol. 16: 137-185.

[23] **Williams, G. L., 1978.** Palynological biostratigraphy, Deep Sea Drilling Project sites 367 and 370. Init. Repts DSDP, 41 : 783-815.

[24] **Herngreen, G. F. W., 1973.** Palynology of Albian-Cenomanian strata of borehole 1-QS-1MA, State of Marañhao, Brazil. Pollen et Spores, 15 (3-4) : 515-555.

[25] **Regali, M. S. P., N. Uesugi** and **A. S. Santos, 1974.** Palinologia dos sedimentos meso-cenozoicos do Brasil (I&II). Bol. Téc Petrobrás..17 : 177-191 and 263-301.

[26] **Sultan, I. Z., 1987.** Palynology of Albian-Cenomanian strata in Mersa Matruh well, Western Desert, Egypt. J. Afr. Earth Sci., 6 : 665-675.

[27] **El Beialy, S. Y., 1993.** Mid-Cretaceous palynomorphs from the Bardawil-1 borehole, north Sinai, Egypt. Cret. Research, 14 : 49-58.

[28] **Batten, D. J., 1982.** Palynofacies, palaeoenvironments and petroleum. Micropalaeontol., 1 : 107-114.