Palynostratigraphic Studies of the Lower Cretaceous Sediments, 
Alamein Formation, Bahrain-I Well in the Northern Part of the Western Desert, Egypt

Gamal M.A. Lashin
Department of Botany, Faculty of Sciences, Zagazig University, Zagazig, Egypt

Abstract: Palynostratigraphic studies of the Lower Cretaceous sediments, Alamein Formation, Bahrain-I well in the northern part of the Western Desert, Egypt, have been carried out from an evolutionary and geological viewpoint. The palynoflora principally consists of pteridophytes, gymnosperms and some rare angiosperm pollen. The microflora shows that the palaeoenvironments were favorable for different kinds of plants. The recovered microflora, therefore, indicates an Early Aptian age and can be extended to the Early Albanian. The palynological data revealed that the North Western Desert (N.W.D.) of Egypt belongs to the North Gondwana phytogeographic province in the Early Cretaceous.

Key words: Lower Cretaceous-North Western Desert, palynofloras, Egypt

INTRODUCTION

Recently palynology has contributed significantly to our knowledge of the evolution and the origin of angiosperms. Palynological studies started almost hundred years ago in Egypt. The main interest is the Lower-Cretaceous microflora and its correlation with the biostatigraphy of the same time in different localities.

In the past few decades, the area of Egypt in general and the Western Desert in particular have been subject to more palynological studies, which threw the light on the microflora characteristics of the Lower-Cretaceous. The studied section of the Bahrain-I borehole is generally barren of diagnostic macroflora and consequently the delineation of the Lower Cretaceous stratigraphic boundaries is rather a questionable problem (Sultan, 1986).

Most of the previous studies of the seventies were concentrated on the subsurface stratigraphy of the Western Desert especially Jurassic and Cretaceous rocks. Noteworthy, the works of Saad (1974 and 1978), Soliman (1976), Sultan (1978), Saad and Ghazaly (1976), Sultan and Soliman (1976) and Aboul Ela (1978 and 1979).


MATERIALS AND METHODS

The study based on the investigation of ten rock samples obtained from Bahrain-I well in the Western Desert (Fig. 1). According to the geological composite well logs of Petroleum companies (Composite well log of the studied well was kindly provided by the Egyptian General Petroleum Authorities), the represented Cretaceous age is Aptian time (Alamein formation). The ages from which we managed to obtain the ten samples are those shown in Fig. 2.

Corresponding Author: Gamal M.A. Lashin, Department of Biological Sciences, Faculty of Sciences, King Khalid University, 9004, Abha, Saudi Arabia
Geological setting:
Bahrein-1 well (B-1): Was drilled by General Petroleum Co. in 1970 and is located at Lat.: 28° 48' North and Long: 26° 33'15" East (Fig. 1). The well traversed strata belonging to Eocene, Cretaceous and Jurassic and was bottomed in the Paleozoic sediments with a total depth of 10022 ft. (Norton, 1967). The sample depths and their lithological description are as shown in Fig. 2. Thus according to the composite well logs the studied samples are mainly Cretaceous particularly Lower Cretaceous (Aptian) and belonging to Alamein Formation.

The ten samples investigated palynologically from that well. The samples lithology consists mainly of alternating shale, silt shale and carbonates. The technical procedure for preparation and palynological investigation of the selected samples was that adopted by Herngreen (1983). Permanent slides were prepared (5 slides from every sample) using glycerin jelly as a mounting medium. The slides were investigated for palynology, facies and deposited environments using the light microscope. Some of these samples especially those of the Upper Cretaceous sediments (mainly carbonates) were found to be palynologically barren. The palynomorphs assemblages are examined and identified. The representative forms illustrated in Fig. 3-23 and their palynogram presented in Fig. 24. The materials were deposited in the Department of Botany, Faculty of Sciences, Zagazig University, Egypt.

Fig. 1: The locality of the studied Bahrein-1 borehole (After Ibrahim, 1996)

Fig. 2: Part of the geological section of Bahrein-1 well, showing depths of studied samples and their lithological description

Fig. 3: Triplanospores sp.

Fig. 4: Todispores minor Couper, 1953
Fig. 5: Trilete spore

Fig. 6: Cyathidites minor Couper, 1953

Fig. 7: Elaterosporites klaszii (Jardine nd Magloire) Jardine, 1967

Fig. 8: Spheripollenites sp.

Fig. 9: Gleicheniidites cf. seronicus Ross, 1949

Fig. 10: Cicatricosporites cf. vernustus Deak, 1963

Fig. 11: Classeopollis sp./cf. C. torosus Reissinger Couper, 1958

Fig. 12: (a) Cyathidites australis Couper, 1953 and (b) Stellatopollis sp.
Fig. 13: *Brenneripollis* sp.

Fig. 14: *Afropollis operculatus* Doyle et al., 1982

Fig. 15: *Classopolis* sp.

Fig. 16: *Tricolporopollenites* sp. x 2000

Fig. 17: Dinoflagellates

Fig. 18: *Eucommiidites* sp.

Fig. 19: *Cretaceiporites polygonalis* (Jardine and Magloire) Hennegouen, 1973

Fig. 20: Chorate dinoflagellates
RESULTS

The samples from Bahrain-1 well, covering an interval (interval from 5296 to 3969 ft.) of Lower Cretaceous sediments (Alamein Fm.) are palynologically studied. The important index sporomorphs, which recovered from the studied well illustrated in Figs. 25, 3-23 and represented by palynogram (Fig. 24).

The palynomorphs taxa comprise more than 28 genera and 29 species (Fig. 24, 25 and 3-23). The taxa characterized by the dominance of pteridophyte spores with the percentages of 60% contribute 13 genera. The Gymnosperms about 20% and contribute 6 genera and 6 species. The angiosperms about 10% contribute 7 genera and 8 species and microphytoplanktons about 10%, contribute 2 assemblages.

The lower part (sample No. 1-4) reveals a less diversity. The pteridophyte sporomorphs characterizing the Early Cretaceous time are recorded and represented mainly by Cycadidites, Todispores, Conocavissmisporites variverrucosus, C. punctatus,

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Taxa</th>
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<tbody>
<tr>
<td>1</td>
<td>*Triplanosporites sp.</td>
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<tr>
<td>2</td>
<td>Todispores minor</td>
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<tr>
<td>3</td>
<td>Triletes spores</td>
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<tr>
<td>4</td>
<td>Matoniadites sp. *</td>
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<td>5</td>
<td>Verrutitites sp. *</td>
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<tr>
<td>6</td>
<td>Lavaquorasporites sp. *</td>
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<tr>
<td>7</td>
<td>Steinkopffites sp.</td>
</tr>
<tr>
<td>8</td>
<td>Cycadidites minor</td>
</tr>
<tr>
<td>9</td>
<td>Gleicheniadites sp.</td>
</tr>
<tr>
<td>10</td>
<td>Cicatricisporites sp.</td>
</tr>
<tr>
<td>11</td>
<td>Peritritites sp. *</td>
</tr>
<tr>
<td>12</td>
<td>Elatroporisae kassaii</td>
</tr>
<tr>
<td>13</td>
<td>Dictyopites sp. *</td>
</tr>
<tr>
<td>14</td>
<td>Monocladites sp. *</td>
</tr>
<tr>
<td>15</td>
<td>Conocavissmisporites variverrucosus</td>
</tr>
<tr>
<td>16</td>
<td>C. punctatus</td>
</tr>
<tr>
<td>17</td>
<td>C. lehmanni</td>
</tr>
<tr>
<td>18</td>
<td>Spherosporites sp.</td>
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<tr>
<td>19</td>
<td>Afrospores sp.</td>
</tr>
<tr>
<td>20</td>
<td>Cicatricisporites sp.</td>
</tr>
<tr>
<td>21</td>
<td>C. lehmanni</td>
</tr>
<tr>
<td>22</td>
<td>Tricolpate sp. *</td>
</tr>
<tr>
<td>23</td>
<td>Reimannopotes sp.</td>
</tr>
<tr>
<td>24</td>
<td>Steinkopffites sp.</td>
</tr>
<tr>
<td>25</td>
<td>*Tricolporate sp.</td>
</tr>
<tr>
<td>26</td>
<td>Chorate dimaflagelletes</td>
</tr>
<tr>
<td>27</td>
<td>Dimaflagelletes and other cystoplates</td>
</tr>
</tbody>
</table>

Fig. 25: The representative palynomorphs of the studied sample (* Not illustrated in the plate (---) Common (- - -), rare (---) very rare
Perotrilites sp., Cicatricosisporites sp., Matonisporites sp., Gleicheniidites, Triplanosporites sp. and Dictyophyllidites sp. The gymnosperm pollen as Ephedrites sp., Monosulcates, Eucommidites sp., Cycadopites and Classopolis sp., were recognized. The angiosperms were rare and represented only by some tricolpate, retinomocoleate types and some ill preserved Afropollis pollen. A few scattered occurrences of some chororate dinoflagellates. Other phytomicroplankton as Chomotrites sp. were also represented.

The uppermost part of the studied interval (sample No. 5-10) was characterized by different varieties of sporomorphs. The pteridophyte sporomorphs characterizing the Early Cretaceous were recorded and represented mainly by Cyathidites, Cicatricosisporites sp., Todisporites, Lycopodiumsporites, Gleicheniidites Concavissimisporites variverrucous, C. puncatus and Perotrilites sp. The gymnosperm pollen of the genera Classopolis, Araucariaites, Sphenopollenites, Ephedrites, Eucommidites, Monosulcates and Callihelesporites are recorded. Angiosperms are common in this interval and represented by Tricolpites, Clavatipollenites, Lilacitides, Cretaceousporites, Afropollis, Brenneripollis, Stellato pollis sp. and Tricolporopollenites sp. Elaterates as Elatesporites klaszii are present. Dinoflagellates are few and scattered occurrences.

**DISCUSSION**

The palynomorphs assemblages of Alamein formation are diverse and possess numerous elements which have been described from Lower Cretaceous and could also be continued upwards from Aptian to Albian. The lack of diversification in the pollen and spores in the studied samples may be related to poor preservation under increasingly sub aerial continental conditions.

At the depth of 5399 ft., the occurrence of Cicatricosisporites sp., Matonisporites equiexinus, Todisporites minor, Gleicheniidites cf. semenicus and Chomotrites sp., (phytoplankton) may attribute to the Lower Cretaceous flora (Bassoumi et al., 1992). Aboul Ela et al. (1989) reported that Cicatricosisporites sp. was common and important during Bajocian-Hauterivian rocks of N.W.D. of Egypt. These taxa are closest to palynoflora previously described from the late Barremian of North and Western Africa (Schrank, 1992; Hermgreen et al., 1996, Jardine, 1967).

At the depth of 4999-4840 ft., the main of pteridophyte spores are Triplanosporites sp., Lavigatosporites, Cyathidites and Lycopodiumsporites. Cyathidites were recorded in Lower Jurassic-Early Cretaceous by Saad and Ghazaly (1976). The gymnosperm pollen as Ephedrites sp., Monosulcates, Eucommidites sp., Cycadopites and Classopolis sp., were also recognized. Ibrahim et al. (1995) stated that the Barremian in NWD is characterized by Ephedrites sp. and primitive angiospermous Lilacitides and fixed that Ephedrites are dominant in Albian of Western Desert microflora. Hermgreen and Chlonova (1981) reported the Classopolis sp., in Neocomian time. The aquatic fern spores appear at first in the Neocomian-Barremian (Abdel Malik et al., 1981) and were known to appear at the first in Lower Cenomanian and continued downward into Albian where they disappeared (Hermgreen, 1975; Batten and Uwins, 1985; Thirou and De Eem, 1985). Angiosperms were very rare. The oldest angiosperm pollen so far was known from Egypt during the Late Barremian (Penny, 1991; Schrank, 1992). Sporadic marine influence in this interval represents by a few of chororate dinoflagellates. These may indicate the regression and transgression of marine shore line or the impact of the terrestrial elements by the river into the sea. Related assemblages have been recorded from different wells in the Western desert by Saad and Ghazaly (1976), Abdel-Malik et al. (1981), Schrank (1987, 1992), Sultan (1986) and El-Shamma and Baicoumi (1992) and attributed to the Lower Cretaceous (Neocomian-Barremian age).

At the depth of 4500-4460 ft., the main of pteridophyte spores were Lavigatosporites, Cyathidites, Lycopodiumsporites, Gleicheniidites and some Perotrilites. The gymnosperm pollen as Ephedrites sp., Cycadopites, Sphenopollenites sp. and Classopolis sp., were recognized. Angiosperms were rare and represented only by some tricolpate, retinomocoleate and some ill preserved Afropollis sp., Pollen. Few of chororate dinoflagellates and some aquatic fern spores of pterotrilites were recorded. These may indicate the regression and transgression of marine shore line or the in put of the terrestrial elements by the river into the sea. Similar assemblages have been recorded from different wells in the Western Desert by Saad and Ghazaly (1976), Sultan (1986), Penny (1991), Schrank (1992) and El-Shamma and Baicoumi (1992) and attributed to the Lower Cretaceous (Barremian age).

At the depth of 4270-4370 ft., the pteridophyte spores as Perotrilites were common. The gymnosperm pollen as Monosulcates, were recognized. The angiosperms were rare and represented by tricolpate, retinomocoleate, Stellato pollis sp. and Elatesporites klaszii pollen. The marine influence in this interval represented by a few scattered occurrences of dinoflagellates and some aquatic fern spores. Related assemblages have been recorded from different wells in the Western Desert by Saad
and Ghazaly (1976), Scharnik (1992), Sultan (1986) and El-Shamma and Baioumi (1992) and are attributed to the Lower Cretaceous (Barremian-Aptian).

At the depth of 4040-4098 ft., the assemblages are *Murospora* sp. (pale preserved), *Afropollis operculatus* and *Clavatipollenites, Cretaceaeportites, Tricolpites, Stellatopollis and Elaterosporites klazii* were reported and indicate age not older than Aptian. In a similar stratigraphic interval a number of angiosperm pollen, has been recorded by Saad (1978), El-Shamma and Baioumi (1992) and Lashin (1999) (from the Salam oil field-Bahariya formation) in the North Western Desert. Moreover, these assemblages could be due to the transition between Aptian and Albian age.

At the depth 3960 ft., the miospores spectra of this interval are characterized by the presence of pteridophyte spores as *Lavigatosporites, Cyathidites and Gleicheniidites*. The gymnosperm pollen as *Ephedripites* sp., *Cycadopites, Eucommiidites* sp. and *Classopolis* sp., are recognized. But angiosperms are represented by tricolpates, reticulococolpates, *Elaterosporites, Tricolporopollenites* sp. and *Cretaceaeportites polygonais* pollen. The oldest angiosperm *Tricolporopollenites* sp. pollen so far known from Egypt and north Africa during Late Aptian or Albian (Penny, 1991; Schrank, 1992; Uwins and Batten, 1985; Warr and Doyle, 1990; Lashin, 1999). The influence of marine is absent in this interval. These may indicate that the terrestrial elements carried by the river fare from the sea. The related assemblages had been recorded from different wells in the Western Desert by Saad and Ghazaly (1976), Abdel-Malik *et al.* (1981), Schrank (1992), Sultan (1986) and El-Shamma and Baioumi (1992) and are attributed to the Lower Cretaceous (Barremian-Albian age).

**Age correlation:** It is well known that, the definition of the Lower Cretaceous according to the microfloras is controversial especially in sections of non-diagnostic macroflora or in terrestrial facies. Also the biotstratigraphic value of many taxa is still uncertain. However, the age assignment of the described assemblage could be achieved by comparison with stratigraphically well defined assemblages in other regions.


However, the Lower Cretaceous is widely viewed as the starting point of angiosperms evolution (Cronquist, 1988). The most important record is the presence of some Elateres and ill preserved angiosperms especially *Afropollis* sp., tricolpate and *Tricolporopollenites* sp. These palynomorphs are important in palynostratigraphy for Upper Aptian and Lower Albian ages in the Northern Egypt and Africa (Jardine, 1967; Sultan, 1978; Saad, 1978; Penny, 1986; El-Shamma, 1991; El-Beialy, 1994). The first appearance of tricolpate pollen indicate strongly the beginning of the Albian as argued by Cooper and Hughes (1963). They described the first tricolpate type in Lower Aptian-Early Albian. Saad (1978) and Doyle *et al.* (1982) considered that the first appearance of *Afropollis jardimus* at higher stratigraphic horizon is a reliable indicator for Aptian age. These are also well known from Aptian to Cenomanian strata of Brazil (Herrgreen, 1973, 1974; Doyle *et al.*, 1977). The later recognized the *A. jardimus* and considered the first appearance of this angiosperm type in equatorial Africa as a stratigraphic marker for Early Aptian age. The tricolpate angiosperms and elater bearing elements are present in the Early Albian-Early Cenomanian (Herrgreen, 1975; Hochuli, 1981; Srivastava, 1984; Herrgreen and Jimenez, 1990; Méon *et al.*, 1996).

**Palaeoenvironments:** The microphytoplanktons are present in some samples in the middle of this interval. These could indicate the mixed freshwater elements with the marine shoreline or indication of near facies during the deposition or sedimentation time (Schrank and Mahmoud, 1998). The microfloras show that the palaeoenvironments was favorable for different kinds of plants (Fig. 24). From the Bh-1 palynogram, the high percentage were the pteridophytes sporomorphs (80%) in the lower part of the profile (sample No. 1-3), also the angiosperms and gymnosperms about 20%. These indicate that the terrestrial wet land and regression of the marine more common in that time. In the middle of the interval (sample No. 4-7), the pollen flora are common and we suggest that the shore line of lagoon or brackish water are dominant and dry period were long (Schrank and Mahmoud, 1998). In the upper part of the interval (sample No. 8), the transgression is more effective and the phytoplankton facies are common (El-Shamma and Arafa, 1988;
CONCLUSIONS

The recovered microflora, therefore, indicates an Early Aptian age and can be extended to Early Albian. The palynological results could reveal also that the North Western Desert (NWD) of Egypt belongs to the North Gondwanan phytoegeoprovincive in the Early Cretaceous time. Results recovered here show that the age may not be Aptian. This is different from that given by composite well logs. Therefore, we argue that the correct age is Late Barremian-Aptian-Early Albian.

Finally, the author suggests that more studies should be carried out in the future for these stratigraphic sediments from different views of biostratigraphy to precisely determine the age of the Cretaceous time in the Western Desert of Egypt.

LIST OF MIOCOPES

All specimens are illustrated in the Fig. (3-23) at the magnification x 800 unless otherwise stated.

Pteridophyte spores:
- *Triplanospores* sp. (Fig. 3)
- *Todisporites minor* Couper, 1953 (Fig. 4)
- *Trilete spore* (Fig. 5)
- *Cyathidites australis* Couper 1953 (Fig. 12)
- *Cyathidites minor* Couper 1953 (Fig. 6)
- *Elaterosporites klaszi* (Jardine and Magloire) Jardine, 1967 (Fig. 7)
- *Gleichenidites* cf. *semionicus* Ross, 1949 (Fig. 9)
- *Cicatricosisporites* cf. *venustus* Deak, 1963 (Fig. 10)

Gymnosperm pollen:
- *Spheroellitites* sp. (Fig. 8)
- *Classopolis* sp./cf. *C. torus*us (Reissinger) Couper, 1958 (Fig. 11)
- *Classopolis* sp. (Fig. 15)
- *Ephedripites* sp., 32 μm (Fig. 21)
- *Eucommidites* sp. (Fig. 18)
- *Cycadopites* sp. (Fig. 22)

Angiosperms like-pollen:
- *Stellatopolis* sp. (Fig. 12)
- *Brenneripolis* sp. (Fig. 13)
- *Afropolis operculatus* Doyle et al., 1982 (Fig. 14)
- *Tricolporopollenites* sp. ×2000 (Fig. 16)
- *Cretaceasporites polygonalis* (Jardine and Magloire) Hennelgreen, 1973 (Fig. 19)
- *C. scabrius* Hennelgreen, 1973 (Fig. 23)

Phytoplankton:
- Dinoflagellates (Fig. 17)
- Chorate dinoflagellates (Fig. 19)

REFERENCES


