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Plant Impressions and Sporomorphs from Kurnub Sandstone Formation in North Jordan

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Impressions of fragments of vegetative organs of a few ferns are recorded from Lower Cretaceous sandstone beds in Kurnub Formation, in Al Baqaa area, North Jordan. Spore-pollen assemblages, also indicating Early Cretaceous age, were found in samples containing plant macro-remnants.

Key Words: Fern Prints, Jordan, Kurnub Sandstone Formation, Sporomorphs

Introduction

The Lower Cretaceous sediments in Jordan consist mostly of sandstone with intercalations of claystones of deltaic and fluvial origin, in addition to marine carbonate interbeds (Fayez and Hakam, 1994). Abed (1978, 1982) described the sandstones in North Jordan in general as varicolored, friable, quartz-arenitic sandstone attains a thickness of 300 m. He postulated that these sandstones are of fluvial origin with a few interfingering shallow marine horizons.

Abed (1982) reported rich fern-like macroflora from the siltstone facies at Kurnub locality in North Jordan.

The present study is an attempt to clarify the stratigraphical position and partially depositional conditions of Kurnub Sandstone (Fig. 1) by studying its macro and microfloral content.

Materials and methods

Materials forming the basis of this study are three slabs containing plant impressions (Plate 1). The flora consists of fragmentary remains of ferns and some other unidentifiable plant remains. All are preserved as impressions without any organic matter remains.

A brief description of the different strata of the Kurnub Formation is given in Fig. 2.

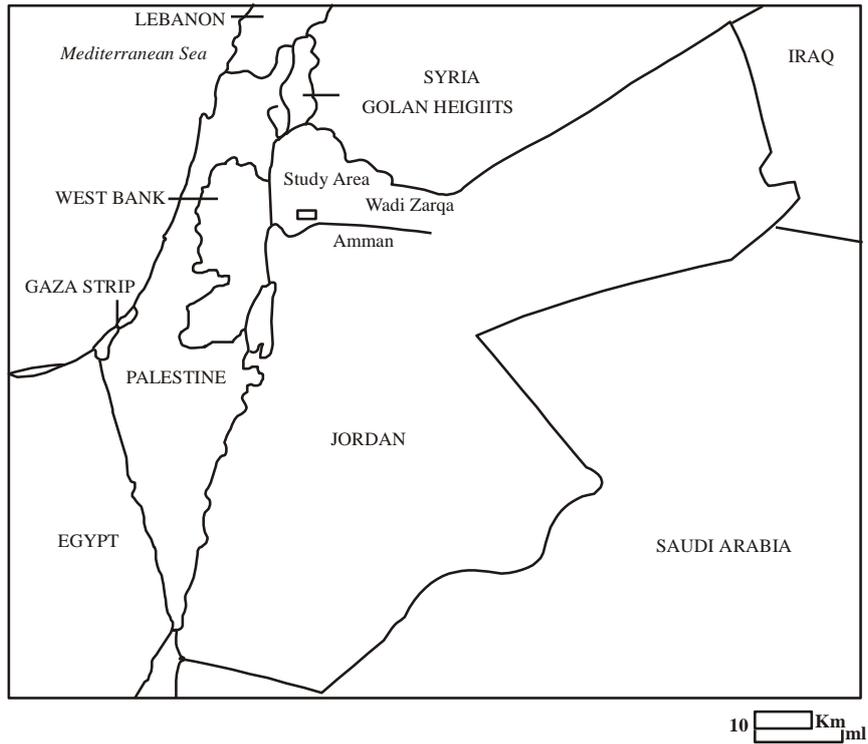


Fig. 1. Location Map of the study Area

For investigation of the palynomorphs, the samples were treated first with HCl. After washing with water, HF was added to the organic matter-containing residue to eliminate the silicate and other inorganic components. Finally, the slides, for light-microscope investigations were prepared in glycerin-jelly.

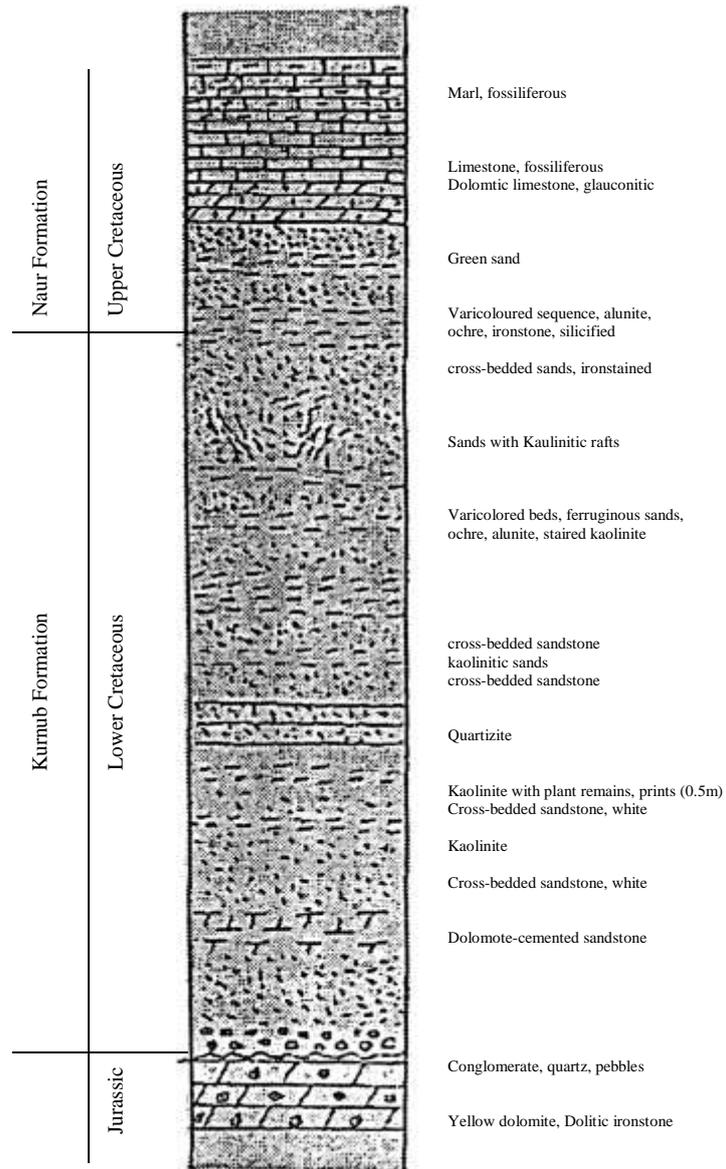


Fig. 2. Stratigraphy of the Kurnub Formation in Al Baqaa area, Jordan.
(Courtesy Prof. Dr. M. El-Sharkawi).

Results

Plant macrofossils

The fossil flora of Kurnub sandstone represented in the three slabs, consists of three taxa. Each slab contains only one taxon. Description is based on the best-preserved fossil fragments of the taxa.

Description of the Macrofossils

Division: Pteridophyta
Class: Pteropsida
Order : Filicales
Family: Aspleniaceae Gray 1821.
Genus: *Asplenium* Linnaeus 1753.
Asplenium whitbyense Heer.
Plate 1, Fig. 1.

Description: The frond is bipinnate but incomplete .The best-preserved specimen is about 60 mm long and 40 mm broad. Rachis of frond is about 6 mm wide. Pinnae are also incomplete, the longest pinna was found to carry 12 pairs of pinnules. The angle of insertion of pinnae on the frond rachis is from 65 to 85 degrees. Pinna rachis is about 0.5 mm wide. Pinnules are opposite. The angle of insertion of pinnules on the pinna rachis is from 80 to 90 degrees. They are crowded on the pinna rachis with thin gaps between adjacent pinnules. Pinnules are quadrangular to rectangular in shape, about 2-mm long and about 1 mm wide , with entire margins and rounded apices . Pinnule midrib is stout at base, terminating at lamina apex. Lateral veins are not clear. Sterile fragments only are present. The frond has a feather shape.

Order: Filicales
Family: Dicksoniaceae Bower 1908.
Genus: *Coniopteris* Brongniart 1849.
Coniopteris arguta Lindley and Hutton
Plate 1, Fig. 2.

Description: The frond is bipinnate but incomplete. The best specimen is 154 mm long, one frond was found to carry 17 pairs of pinnae. Rachis of frond is about 12 mm wide. The angle of insertion of pinnae on the frond rachis is 80 to 90 degrees. Pinnae are opposite. They are crowded on the frond rachis with gaps, about 0.5 to 2 mm wide, in-between.

The largest pinna is about 90-mm long and 10 mm broad and carries 30 pairs of pinnules. Pinna rachis is distinct, about 1 mm wide. The pinnules are nearly perpendicular to the pinna rachis. They are opposite or almost so. They are crowded on the pinna rachis with gaps about 0.2 to 0.4-mm wide in-between. There is no connecting web. Pinnules are 5 to 7 mm long and 2 to 5 mm wide (largest pinnules are at the middle of pinna), with entire margins and obtuse apices. Pinnule midrib is very thin. Venation is not visible. Sterile fragments only are present.

Filicales Increate Sedis (Fern - like foliage)

Genus: *Callipteridium* Weis 1870.

Callipteridium pteridium Schloth.

Plate 1, Fig. 3 .

Description: This is a species of fern -like foliage. Entire frond is unknown. The specimen is 11 mm long and 6 to 7 mm wide. Pinna is incomplete; it carries 30 pairs of pinnules. Pinna rachis is about 1 mm wide. The angle of insertion of pinnules on pinna rachis is from 50 to 60 degrees. Pinnules are opposite. They are crowded on the pinna rachis with thin gaps about 1.2 mm wide in-between. Connecting web is distinct. Pinnules are well preserved, triangular being 3 to 4 mm long and about 0.5 to 0.7 mm wide, with entire margins, and blunt rounded apices. Pinnule midrib is thin but distinct. This specimen has sterile pinnules only.

Comparisons

Morphological convergence is evident between the foliage of the present specimen of *Asplenium whitbyense* and foliage of *Anemia fremontii* Knowlton recorded by Crabtree (1988) from Albian of Southwestern Montana (U.S.A), but *A. fremontii* has linear pinnules with acute apices. The present specimen is identical with *A. whitbyense* which was described from Upper Jurassic- Lower Cretaceous beds of Abu- Darag, Egypt (Darwish ,1990). *A. whitbyense* resembles also *Cladophlebis* sp. reported from Upper Jurassic -Lower Cretaceous beds of Abu- Darag, Western side of Gulf of Suez (Darwish, 1990) but here the pinnules are smaller and have almost quadrangular shape, not oblong.

Coniopteris arguta is similar to *Phlebopteris* but is separated on basis of its bipinnate leaves (*Phlebopteris* being once pinnate Person & Delevoryas, 1982). The present specimen is closely similar to a specimen of *C. arguta* described by Person & Delevoryas (1982) from the Jurassic of Mexico but here the pinnae are perpendicular to the frond rachis. *C. vinyardii* described by Crabtree (1988) from the Albian of Southwestern Montana (U.S.A.) differs from the present *C. arguta* in having tripinnate leaves and pinnae are not perpendicular to the frond rachis. *C. arguta* reported here is very similar to specimens of the same species described from Upper Jurassic- Lower Cretaceous of Abu-Darag ,Egypt by (Darwish ,1990) but here pinnules are larger.

Callipteridium pteridium differs from *Odontopteris cantbrica*, described by Boersma (1978) from Early Stephanian of Germany in having alternate pinnules, and the connection between pinnules is very thin. *C. pteridium* reported here is identical with that recorded from Abu-Darag locality (Darwish ,1990) .

This means that the species *A. whitbyense*, *C. arguta*, and *C. pteridium* are common to both Kurnub and Abu- Darag localities . Further detailed studies of both localities may prove that there are more species in common , not only concerning ferns but also Cycadophytes and Coniferales (cf. Edwards, 1929 ; El-Saadawi and Farag,1972 ; El-Saadawi and Kedves 1991) .

The Kurnub flora is also similar to Mesozoic floras in other strata of the world. For example in North America, ferns are so prevalent and abundant in Late Jurassic and Early Cretaceous megaflores (Niklas, et al. 1980; Crabtree, 1988; Rushforth 1976). El-Saadawi and Farag (1972) and Darwish (1990) gave also similar statements concerning the abundance of ferns in Early Cretaceous of Abu-Darag.

Plant Microfossils

The following is the taxonomic list of the fossil miospore species identified in the present study. The system of classification adopted here is a semi-natural one; based on Inversen and Troels-Smith (1950) for the pollen grains, Potonie (1956) for the spores and Erdtman (1948) for the morphological terminology with slight modification. The trilete spores are classified according to the nature of exine sculpture. All psilate spores are grouped together under Psilatriteles.

1.Division Sporites

A. Subdivision Triletes

Group Psilatriteles

Genus: *Cyathidites* Couper 1953.

Cyathidites australis Couper 1953 (Plate 2, Figs.1 & 2)

Cyathidites minor Couper 1958 (Plate 2, Fig.3)

Cyathidites sp. (Plate 2, Fig. 4).

Genus: *Dictyophyllidites* Couper 1958, emend, Dettmann 1963.

Dictyophyllidites cf. *harrisii* Couper 1958 (Plate 2, Fig.5)

Genus: *Concavisorites* Pflug 1953.

Concavisorites twentianus Burger 1966 (Plate 2, Fig. 6)

Group Verrutriteles

Genus: *Concavissimisporites* (Del. & Sprum. 1955)

Concavissimisporites sp. (Plate 2, Fig. 7)

Genus: *Verrucosisporites* (Ibrahim 1933) Pot. & Kremp 1954

Verrucosisporites cf. *rarus* Burger 1966 (Plate 2, Fig. 8)

Verrucosisporites sp. (Plate 2, Fig. 9)

Group Striatriteles

Genus: *Cicatricosisporites* Potonie and Gelletich 1933.

Cicatricosisporites cf. type H. Saad 1978 (Plate 2, Fig. 10)

Cicatricosisporites sp. 1 (Plate 2, Fig. 11)

Cicatricosisporites sp. 2 (Plate 2, Fig. 12)

Group Perinotriteles

Genus: *Perotriteles* Erdtman 1948 ex Couper 1953

Perotriteles pannuceus Brenner 1963 (Plate 2, Fig. 13)

Perotriteles perinopustulosus Reyre 1973 (Plate 2, Fig.14)

Perotriteles sp.1 Reyre 1973 (Plate 2, Fig. 15)

Perotriteles sp. (Plate 2, Fig. 16)

B . Subdivision Monoletes

Group Azonomoletes

Genus : *Laevigatosporites* Ibrahim 1933

Laevigatosporites sp. (Plate 3, Fig. 4)

Division Pollenites

A. Subdivision Gymnospermae

Group Tetradae

Genus: *Classopollis* (Pflug 1953) Pocock and Jansonicus 1961.

Classopollis tumulus? (Plate 4, Fig. 20)

Classopollis sp. (Plate 4, Fig. 21)

Group Vesiculatae

- Genus *Callialasporites* Sukh Dev 1961
Callialasporites dampieri (Balme 1957) Dev 1961 (Plate 3, Figs. 1, 2)
Callialasporites segmentatus (Balme 1957) Dev 1961 (Plate 3, Fig. 3)
- Genus *Araucariacites* Cookson 1947 ex Couper 1953
Araucariacites australis Cookson 1947 (Plate 3, Figs. 5, 6)
Group Inaperturatae
- Genus: *Inaperturopollenites* Thomson and Pflug 1953.
Inaperturopollenites sp. 1 (Plate 3, Fig. 7)
Inaperturopollenites sp. 2 (Plate 3, Fig. 8)
Group Polyplacatae
- Genus: *Ephedripites* Bolkhovtina 1953 ex Potonie 1958.
Ephedripites type E. Saad 1978 (Plate 3, Fig. 9)
Ephedripites multicostatus Brenner 1963 (Plate 3, Fig. 10)
Ephedripites cf. *Validus* Brenner 1968 (Plate 3, Fig. 11)
Ephedripites sp. 1 (Plate 3, Fig. 13)
Ephedripites sp. 2 (Plate 3, Fig. 14)
Ephedripites sp. 3 (Plate 3, Fig. 15)
Equisetosporites cf. *ambigus* Singh 1983 (Plate 3, Fig. 12)
Group Monosulcatae
- Genus: *Cycadopites* Wilson and Webster 1946.
Cycadopites glottus (Brenner) Wingate 1980 (Plate 4, Figs. 10, 11) *Cycadopites* sp. (Plate 4, Figs. 12 & 13)
Group Praecolpatae
- Genus: *Eucommiidites* (Erdtmann 1948) Hughes 1961.
Eucommiidites troedssonii Erdtmann 1948 (Plate 4, Fig. 1)
Eucommiidites spp. (Plate 4, Figs. 14-17)
Subdivision Angiospermae
Group Monocolpatae
- Genus: *Monocolpopollenites* Thomson and Pflug 1953.
Monocolpopollenites type A, Saad & Ghazaly 1976 (Plate 4, Fig. 4)
Monocolpopollenites sp (Plate 4, Figs. 5-8)
Group Tricolpatae
- Genus: *Tricolpites* Cookson 1947 ex Couper 1958.
Tricolpites cf. *virgus* (Groat et. al.) 1961 (Plate 4, Fig. 18)
Tricolpites sp. (Plate 4, Figs. 2, 3 & 19)
- Genus : *Liliacidites* Couper 1953.
Liliacidites sp. (Plate 4, Fig. 9)

Plant tissue remnants

Epidermis fragments of Monocotyledonopsida type (Plate 5, Figs. 3, 5 & 6)
Gymnosperm secondary xylem fragments of tracheids with bordered pits (Plate 5, Fig. 4).
Unidentified plant tissues (may be tissues of ferns?) (Plate 5, Figs. 1 & 2).

General Discussion And Conclusions

The palynomorph assemblages of Kurnub Sandstone are not diverse and possess numerous elements which have been described from Early Cretaceous and could also be

continued downwards to Late Jurassic. As far as known, the definition of Late Jurassic Early Cretaceous contact is always a matter of controversy, as the microfloras of the two ages are too closely similar and biostratigraphic 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.

The assemblage as a whole comprises 18 genera and 48 species.

It is characterized by the dominance of trilete spores, which contribute 7 genera and 15 species. The monoletes is represented by 1 genus and 1 species. The gymnosperm pollen comprise 7 genera and 16 species. The angiosperm pollen are represented by 3 genera and 6 species.

The distribution of the spores and pollen grains in Kurnub sandstone Formation indicates that the climate changed from humid to arid-semiarid (Pteridophytic spores form 44%, gymnosperm pollen grains 39% and angiosperm pollen 17%). The appearance of angiosperms indicates that abrupt changes in environmental conditions have taken place.

The presence of some sporomorphs such as *Inaperturopollenites* and *Cyathidites* have been reported by Saad and Ghazaly (1976) from Kharga Oasis in Egypt and by Fayez and Hakam (1994) from Kurnub sandstone in Wadi Zarqa, in North Jordan. They gave them late Jurassic-Early Cretaceous age but existence of angiosperm excludes the Late Jurassic. Generally recognized angiosperm forms appear in the fossil record in Early Cretaceous times (Cran et al., 1986).

Herngreen and Chlonova (1981) gave the gymnosperm pollen grains, *Araucariacites*, *Inaperturopollenites*, *Classopollis* and *Eucommiidites*, Late Jurassic to Neocomian age, and they gave the monolete gymnosperm pollen a Neocomian age.

Ibrahim, et al. (1995) stated that Barremian age is characterized by the first incoming of *Ephedripites* pollen and primitive angiosperm pollen like *Liliacidites* and others. *Ephedripites* and others dominate the Albian microflora. The percentage of angiosperm pollen increased during the Aptian, tricolpate pollen, *Afropollis* and others appeared. Tricolpate angiosperm and elater bearing elements are present in the Early-Middle Cenomanian.

Aboul Ela, et al. (1989) reported that *Cicatricosisporites* is important through the Barriasian-Hauterivian rocks of NW Europe and have been shown by Huges and Croxton (1973) and many other workers to have considerable value for stratigraphic correlation. On the other hand, Herngreen and Chlonova (1981) stated that the presence of *Cicatricosisporites* indicates an age that is not older than Late Jurassic. This is supported by the opinion of Lantz (1958) and Jakhovskty (1959) that this genus appeared in Kimmeridgian-Purbeckian age. *Perotriletes* appeared in the Neocomian-Barremian (Abdekmalak et al. 1981). *Perotriletes pannuceus* is known to appear first in Late Cenomanian and continued down into Albian where it disappeared (Herngreen 1975).

Cycadopites, *Eucommiidites troedssonii*, *Ephedripites* type E-Saad (1978) are described by Schrank (1987) from Late Jurassic-Early Cretaceous of the North Western Desert of Egypt from Barremian of Umbarka well. *Eucommiidites*, *Ephedripites* and *Araucariacities* characterize the pre-Albian of West Africa-South America province (WASA) as suggested by Herngreen and Chlonova (1981) and as Aboul Ela, et al. (1989) stated that this microflora is found at Abu Darag in Egypt. Huges and McDougall (1987) mentioned that the first appearance of *Ephedripites* is in Barremian-Albian age.

El-Saadawi and Kedves (1991) found *Classopollis*, *Eucommiidites*, *Ephedripites*, fragments of Monocotyledonopsida and Gymnosperm secondary xylem fragments of tracheids with bordered pits at Abu Darag in Egypt, they gave it an Early Cretaceous age.

The first appearance of the *Tricolpites* indicates strongly the beginning of the Albian, as Couper and Huges (1963) define the first appearance of *Tricolpites* pollen to be in the Late Aptian to Early Albian. Fayed and Hakam (1994) found *Tricolpites* in the same age from Kurnub Sandstone. Saad (1975) gave Cretaceous at Kharaga Oasis a Santonian-Campanian age based on the presence of *Monocolpopollenites* and *Tricolpites*. Magdy (1998) said that the presence of relatively large angiosperm pollen (e.g. *Tricolpites spp.*) indicates a Campanian age for the Quseir Formation ,Kharga Oasis, (Egypt).

The recovered microflora, therefore, indicates an Early Cretaceous age and can be extended to Late Jurassic. However, the Early Cretaceous is widely viewed as the starting point of angiosperm evolution (Beck 1976, Cronquist 1988).

The predominance of fern foliage and fine delicate parts of plant remains in the studied sediment can be attributed to prolonged period of transportation, where the large heavy woody fragments have been left and these delicate plant tissues have been transported away to the site of deposition. The apparent lack of diversification in the pollen and spores in the studied samples may be related to poor preservation under increasingly subaerial continental condition.

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