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# On the Occurrence and Significance of Charophyte from Ar Rajban Member, Kiklah Formation, Wadi Ar Rajban, Mizdah Area, North West of Libya

**Abstract:** Twelve samples containing charophytes were taken from Ar Rajban Member of Kiklah Formation of Wadi Ar Rajban surface section, Mizdah area, northwestern Libya. The study reveals well preserved charophyte assemblages that are closely associated with sandy to argillaceous limestone and calcareous siltstone samples. The lower part of the section yielded a charophyte assemblage that includes *Porochara douzensis*, *P. plameri*, and *P. mastricta* of typically Late Jurassic age. On the other hand, the upper part yielded assemblages containing *Atopochara trivolvis trivolvis*, *Flabellochara harrisi*, *Lamprothamnium cylindricum*, and *Porochara anluensis* of definitely Early Cretaceous age. The recorded charophyte assemblages strongly indicated that the Ar Rajban Member was deposited under a lacustrine (fresh water) environment and represented ages from the Late Jurassic to the Early Cretaceous.

## Introduction

Charophytes are considered to be a group of microfloral autochitaneous plants that physiologically and biochemically are similar to other genera of green algae. They develop primarily in suitable water conditions especially in pond and lake environment (Johnson, 1961; Wray, 1977). This group of algae has been intensively studied and during the last century some authors concluded that charophytes possess a number of morphological and cytological characters of higher plants, indicating

عن تواجد و أهمية الطحالب الخضراء (كاروفيت) في عضو الرجبان ، تكوين الكيكلي، وادي الرجبان، منطقة مزده، شمال غرب ليبيا. مصطفى منصور إمام

المستخلص: يتناول هذا البحث دراسة اثني عشر عينة سطحية أخذت من عضو الرجبان التابع لتكوين الكيكلي بوادي الرجبان، منطقة مزده، شمال غرب ليبيا. وقد استهدفت الدراسة البحث عن الطحالب الخضراء (كاروفيت) الموجودة في عضو الرجبان. وقد أظهرت الدراسة إلى وجود أنواع وأجناس عديدة من الطحالب الخضراء (كاروفيت) مصاحبة للصخور الجيرية الطينية والصخور الغرينية المتكلسة. وقد تم فصل بعض الأنواع في الجزء الأسفل من القطاع والتي تنتمي إلى عصر الجوراسي المتأخر مثل: *mastricta*, *Porochara douzensis*, *Porochara plameri*, *Porochara* الجزء الأعلى من القطاع فقد تم فصل بعض الأنواع التي تنتمي إلى عصر الكريتاي المبكر مثل: *cylindricum*, *Porochara anluensis*, *trivolvis*, *Flabellochara harrisi* *Lamprothamnium* *Atopochara* و قد تم تصوير هذه الأنواع باستخدام المجهر الإلكتروني الماسح و من دراسة الطحالب الخضراء (كاروفيت) تم استنتاج الظروف البيئية القديمة التي سادت خلال ترسيب عضو الرجبان التابع لتكوين الكيكلي في وادي الرجبان.

that they may represent a link between the green algae and higher vascular plants (Hori *et al.* 1985; Hori and Osawa, 1987). The gyrogonites of the charophytes (calcified female reproductive organs) are the only fossil remains of this microflora. The charophyte taxa is principally considered to be an index of lacustrine environment (Grambast, 1968 & 1970 and Soulie-Märsche, 1991 & 1994; Riveline *et al.* 1996).

## Previous works

Since the works of Peck (1931, 1938, & 1957) on the Early Cretaceous charophytes of Texas and Oklahoma, U.S.A., this type of green algae taxon has received the attention of many workers around the world due to its stratigraphic and paleoecologic significance. Among the important authors are: Mädler, 1952; Wang *et al.* 1976; Grambast, 1975; Hung, 1979; Wang, 1978; Bhaita and Mannikevil, 1977; Feist and Grambast, 1984; Feist and Schudack, 1991; and Soulie-Märche, 1991; 1994.

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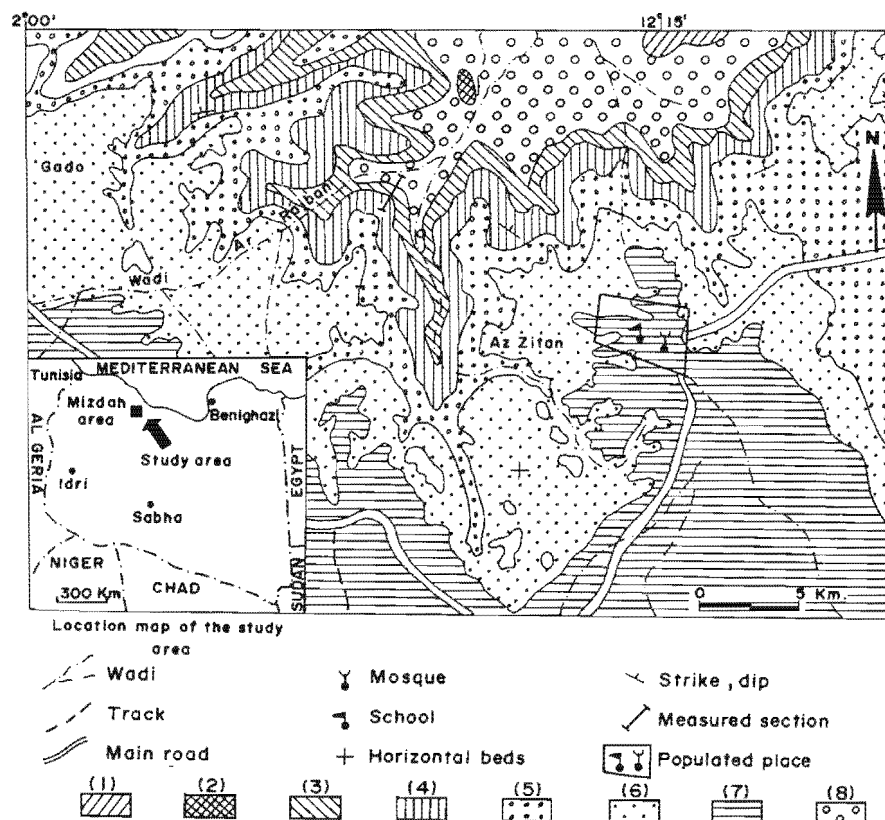
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Viterbo (1968) reported for the first time in Libya the occurrence of the charophyte, *Clavator harrisi* Peck, in an assemblage of ostracods reported from the subsurface Nubian complex of the Sirte basin, northern Libya, and assigned these deposits to an Early Cretaceous (Aptian) age. Since then, no one else has worked on the charophyte flora in the region until the study presented herein. The purpose of the present study is to document the importance of this charophyte assemblage, which has been recorded for first time from the stratigraphic sequence at Wadi Ar Rajban, Mizdah area. It clearly enables the paleoecologic significance to be interpreted as well as establishing an age assignment for the studied section.

### Geological Setting

The present study is based on sample material collected mainly from one measured surface section, Wadi Ar Rajban (Lat.  $31^{\circ} 57' N$  & Long.  $12^{\circ} 13' E$ ) in the northwestern part of the Mizdah area, northwestern Libya (Fig. 1). This locality represents the same interval and general time as the type of section of the Ar Rajban Member of Kiklah formation (Hinnawy and Chesitev, 1975). In the study area, Ar Rajban Member constitutes the upper

member of Kiklah Formation and conformably overlies the Shakshuk Member (sandstone and limestone facies) and unconformably underlies the Cenomanian Ain Tobi Member of Sidi As Sid Formation (Table 1). Lithologically, the Ar Rajban Member is composed mostly of siliciclastic sequence with fine to medium usually coarse grained sandstone, and it is occasionally conglomeratic at its base. This cross-bedded sandstone sequence attains a thickness of about 75m. Field observations demonstrate that Ar Rajban section can be subdivided into two main lithologic units. The lower unit consists mostly of reddish to brownish yellow conglomeratic cross-bedded sandstones with claystone and siltstone intercalations. This unit is poorly fossiliferous with the exception of siliceous botryoidal concretions and silicified wood. The upper lithologic unit also consists of alternating beds of yellowish red cross-bedded sandstones, with planar structure pebbly to conglomeratic sandstone and siltstone and thin bands of sandy to argillaceous limestones which contain thin gypsum beds and veinlets (Fig. 2). Plant remains and silicified woods are fairly common fossils in this member.



**Fig. 1.** Simplified geological map of Wadi Ar Rajban area (modified after IRC, 1980)

1 = Khashm Az Zarzur Mb., 2 = Shakshuk Mb., 3 = Ar Rajban Mb. 4 = Sidi As Sid Fm., 5 = Nalut Fm., 6 = Qasr Trigrinah Fm. 7 = Mazuzah Mb. of Mizdah Fm. 8 = Recent wadi deposits

**Table 1.** Sedimentary rock units exposed in Wadi Ar Rajban, Mizdah area, NW Libya. (after Novoic, 1977)

		Age	Rock units	
		Quaternary	Genetically various types of sediments	
Cretaceous	Late	Campanian	Mizdah Formation	Thala Member
		Santonian		Mazuzah Member
		Late Turonian - Coniacian	Qasr Tigrinah Formation	
		Early Turonian	Nalut Formation	
		Cenomanian	Sidi As Sid Formation	
	Early	Oxfordian - Aptian	Kiklah Formation	Ar Rajban Member
Jurassic	Late			
	Middle	Callovian	Kiklah Formation	Shakshuka Member
		Bathonian		Zarzur Member

## Material and Methods

The present study is based primarily on the examination of 12 samples (listed 1-12 in Fig. 2) collected mainly from the Wadi Ar Rajban section, Mizdah area, northwestern Libya. The charophyte assemblages were recovered essentially from yellowish gray fossiliferous sandy to argillaceous limestones with greenish gray fissile siltstone to beds that are interbedded in the main siliciclastic section. The collected samples were crushed to very small sizes (from 1-3 mm) in the laboratory and carefully treated by washing and sieving. These samples were subsequently dried, put in trays and scanned under a binocular microscope for picking the specimens. The charophytes have been described, identified, and figured using a scanning electron microscope (SEM). It is noteworthy that the rather bad preservation of these fossils has led to the belief that the conditions for preservation were less than favorable and might have negatively affected the quantity and quality of these microfauna.

## Systematic Description

The classification and the descriptive terms employed in the present work follow that of Peck (1957) and Grambast (1974) as well as the recently modified classification proposed by Schudack (1986 & 1993). The following systematic record includes 11 charophyte species belonging to 6 genera and 3 families. In the following treatment, only the main morphological features and measurements of the examined taxa are recorded; additionally local and worldwide stratigraphic ranges are discussed.

- Division: **Charophyta** Migula, 1890.  
 Class: **Charophyceae** G.M. Smith, 1938.  
 Order: **Charales** Richard *in* Kunth, 1815.  
 Family: **Clavatoraceae** Pia, 1927.  
 Subfamily: **Atopocharodieae** (Peck, 1941) Grambast, 1969.  
 Genus: **Atopochara** (Peck, 1938)  
*Atopochara trivolvis trivolvis*  
 Grambast, 1968  
 (Pl. 1, Figs. 1 & 2)

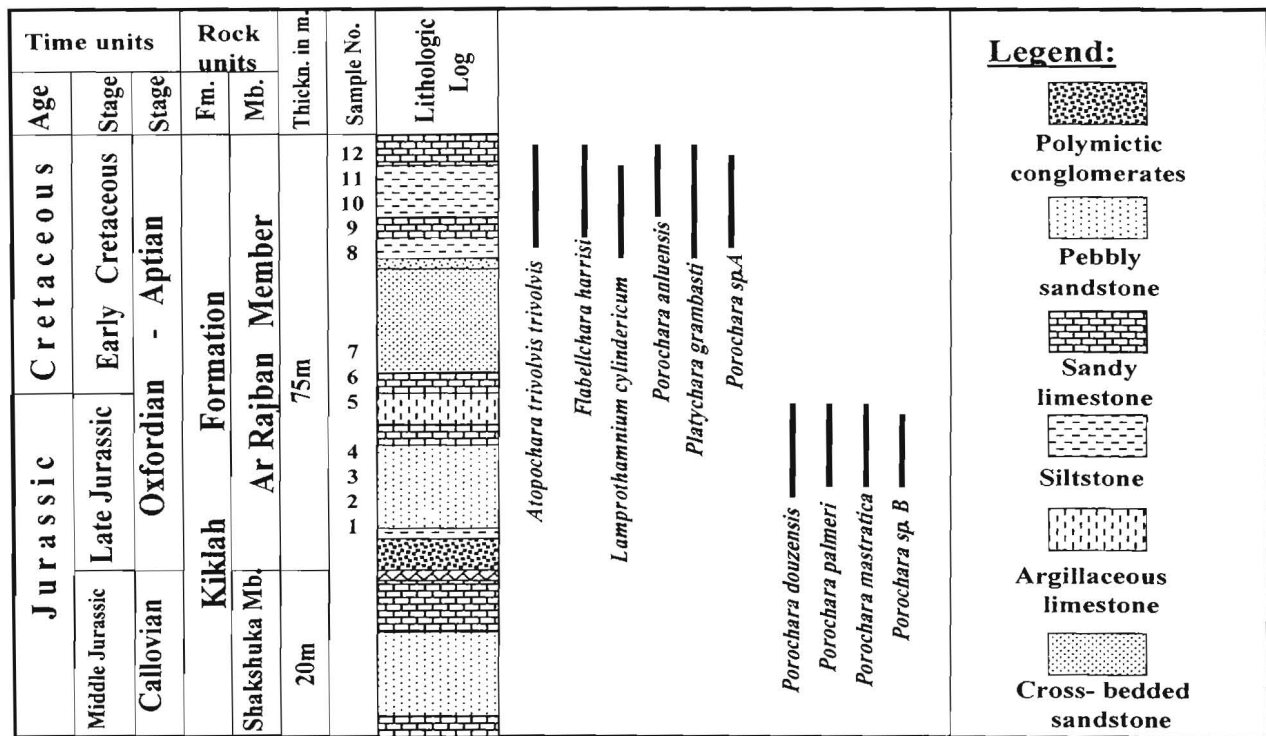


Fig. 2. Stratigraphic distribution chart of the identified charophytes in Ar Rajban Member, Kiklah Formation, Wadi Ar Rajban, Mizdah area, NW Libya

**Description:** Small sized utricles possessing three rayed symmetry, each ray consisting of short vertical units originating near the basal opening and ascending to the equatorial plane. This unit possesses, as well one short right handed cell and two longer cells. Sinistrally spiralled cells extending from the equator to near the summit opening which are surrounded by crests of three cells.

**Measurements:** Height = 746 - 1053  $\mu\text{m}$  & Width = 692 - 931  $\mu\text{m}$ .

**Material:** Seven complete, well preserved specimens and four strongly crushed, badly preserved ones are observed in the examined samples.

**Remarks:** The above mentioned morphological features closely fit the original description of the holotype given by Peck (1938 & 1957). However, the specimens under consideration are shown smaller in size. It is noteworthy that the antheridium (male gametangium) recorded by Grambast (1968) is not observed and this may be attributed to the ecological conditions and mode of preservation.

**Occurrence:** The named taxon is the most common *Clavatoraceae* species recorded in the present materials. It is recorded in samples WR. 7, 9, 10 and

11. This taxon represents the primitive form of *Atopochara* sp., which makes its first appearance during the Early Cretaceous (Aptian) (Grambast, 1968; Martin-Closas, 1989; Feist and Schudack, 1991; Martin-Closas and Salas, 1996). This taxon has been recorded from the Middle East; Early Cretaceous (Aptian) of Syria (Bellen, 1948), Algeria (Barr and Magne, 1955), and Southern Lebanon (Grambast and Lorch, 1968). In Europe, it has been recorded from the Aptian sediments of Italy (Sirna, 1963), Bulgaria (Palamarev, 1971), and Spain (Brenner, 1976). It was recognized in the U.S.A. by Soulie-Märche, (1991). It was also reported from China (Li, 1981; Wang and Lu, 1982; Wang, Lu and Zhao, 1985).

Subfamily: **Clavatoroideae** (Pia, 1927)  
Grambast, 1969.

Genus: **Flabellochara** Grambast, 1959.  
*Flabellochara harrisi* (Peck, 1941)  
(Pl. 1, Figs. 3 & 4)

**Description:** Utricles with heart-like appearance, small size, consisting of a bilateral mode: (1) anterior vertical cells running from basal to apical opening and (2) lateral sides with small basal cells. The gyrogonite, visible inside the utricle, is of ovoidal shape and sinistrally coiled.

**Measurements:** Height = 590 - 763  $\mu\text{m}$ . & Width = 465 - 543  $\mu\text{m}$ .

**Material:** Nine whole, well preserved specimens, seven incomplete specimens and four crushed to badly preserved specimens are recorded.

**Remarks:** The measurements, cell construction and general appearance of growth habit closely fit the holotype as illustrated and figured by Peck (1941 & 1957). Moreover, our specimens show great similarities to the paratypes described by Soulie - Märsche (1994) from Early Cretaceous (Aptian) deposits of the U.S.A. However, our taxon differs slightly from Soulie-Märsche's specimens in the absence of the fan-like structure of the lateral cells.

**Occurrence:** In the present study this taxon was recorded from the uppermost part of the Ar Rajban section, samples WR. 9, 11, and 12 (Fig. 2). This taxon has a wide geographic distribution. It was originally recorded from the Aptian deposits of North America (Peck, 1957; Wayland, 1954). It is also recorded from Aptian deposits of the Sirte basin, Libya (Viterbo, 1968). Further records are from the Early Cretaceous of Italy (Sirna, 1963), Spain (Martin - Closas and Grambast, 1986); China (Li, 1981; Wang and Lu, 1982). It is recorded also from South America in Argentina (Musacciho, 1971).

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Family: **Characeae** Richard *in* Kunth 1815.  
 Subfamily: **Charoideae** Leonhardi, 1863.  
 Genus: **Lamperothamnium** Groves, 1916.  
*Lamperothamnium cylindricum*  
 (Peck, 1941)  
 (Pl. 1, Figs. 5 & 6)

**Description:** Gyrogonite is typically cylindrical (ellipsoidal) with seven to eight sinistrally concave to flat spiralled cells, visible in lateral view. These cells are ascending to a truncate apical area. The cell ends are weakly calcified with a flat apical area, and superficial basal opening with a visible basal plate.

**Measurements:** Height = 573 - 658  $\mu\text{m}$  & Width = 374 - 632  $\mu\text{m}$ .

**Material:** Thirteen well preserved specimens and eight crushed ones are recorded.

**Remarks:** This genus was first proposed by Peck (1937) as *Aclistochara*, amended by him in (1941) and then redefined by Madler (1952) as *Obtusochara*. Other authors noted that this genus has morphological features very similar to generic features of *Lamperothamnium* and clearly belongs to that genus (Castel and Grambast, 1969; Soulie - Märsche, 1982 & 1989). This species is the most abundantly representative form of Aptian charophyte of the genus *Lamperothamnium* in the Libyan collection. It shows great similarities to *Lamperothamnium polyspiratum* (Mädler, 1952) recorded from Late Jurassic deposits of NW Germany (Shudack, 1990), but the latter species shows more spirals in lateral view (8-11) and also has no central apical peak.

**Occurrence:** This taxon has been recorded in the studied material from samples WR 8, 10, and 11. It was previously recorded from the Early Cretaceous of China (Wang, 1978) and Aptian deposits in the U.S.A. (Soulie - Märsche, 1994). The majority of the authors strongly indicate that this taxon is an index charophyte for the Early Cretaceous (Aptian) age.

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Genus: **Platychara** Grambast, 1962  
*Platychara grambastii* Peck &  
 Forester, 1979  
 (Pl. 1, Fig. 7 & B).

**Description:** Gyrogonite oblate with depressed and flat summit. Basal area is flat to rarely sunken. Four to six concave usually planar, spirals are visible in lateral view. Apical opening is with deep cog - wheel shaped furrow. Small basal pore encircled with sutures.

**Measurements:** Height = 120-510  $\mu\text{m}$  & Width = 670 - 795  $\mu\text{m}$ .

**Material:** Seven complete, well preserved specimens, and four badly preserved ones are recorded.

**Remarks:** The specimens under consideration show a great resemblance to the holotype that was figured and described by Peck and Forester (1979) in the deep furrow surrounding the apical opening as well as the low number of spirals. However, our specimens have slightly smaller dimensions and are externally flattened.

**Occurrence:** This taxon has been recorded in samples WR. 8 to 12. This species has been reported before from the Late Cretaceous (Maastrichtian) deposits of Jamaica (Peck & Forester, 1979). However, in the present study this taxon is observed at a lower stratigraphic level (Early Cretaceous) than that recorded by the previous authors.

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Genus: **Sphaeochara** (Mädler, 1952)  
*Sphaerochara* sp.  
 (Pl. 1, Fig. 12B)

**Description:** Small gyrogonites of globular shape with sharp and narrow spiral ridges, spiral ends joining on the slightly protruding apex with visible basal plug at the basal part.

**Measurements:** Height = 330-380  $\mu\text{m}$ . & Width = 260-320  $\mu\text{m}$ .

**Materials:** Five well preserved specimens and three crushed ones are observed.

**Remarks:** The specimens are entirely consistent in morphological features and dimensions with the paratypes described and figured by Soulie - Märtsche (1994) from the Aptian deposits in the U.S.A. but our figured specimens show slightly smaller apical and basal pores.

**Occurrence:** This taxon was recorded in the present study in samples WR. 10, 11 and 12. It was previously reported from the Early Cretaceous (Aptian) deposits in the U.S.A by Soulie - Märtsche (1994), and from Early Cretaceous of Jamaica, South America (Kumar & Grambast, 1984).

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Family: **Porocharaceae** Grambast, 1962.  
 Subfamily: **Porocharaoideae**  
*Porochara anluensis* Wang, 1978.  
 (Pl. 1, Figs. 13 A & B)

**Description:** Gyrogonite ellipsoidal, eight to ten spirals are visible in lateral view with a less convex surface, rose - shaped apical pore with slightly larger basal pore surrounded by swellings due to suture expansions.

**Measurements:** Height = 1100 - 1260  $\mu\text{m}$ . & Width = 790-980  $\mu\text{m}$ .

**Materials:** Seven well preserved specimens and five crushed ones are observed.

**Remarks:** The specimens are entirely consistent in morphological features and dimensions with the paratypes described and figured by Wang *et al.* (1976) and Hung (1979) except that our figured specimens show slightly smaller apical and basal pores. This taxon is strongly characterized also by its rose-shaped apical pore which form remarkable features in other *Porocharaceae* (Kumar and Grambast, 1984).

**Occurrence:** This taxon was recorded in the present study in samples WR. 10, 11 and 12. It was previously reported from the Early Cretaceous of Spain (Grambast, 1975), China (Wang *et al.*, 1976) from France (Feist and Grambast, 1976) as well as from the Early Cretaceous of Jamaica, South America (Kumar & Grambast, 1984).

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*Porochara douzensis* (Feist and Grambast - Fessard, 1984) Sdudack, 1986.  
 (Pl. 1, Figs. 8, 9, 15)

**Description:** Ellipsoidal gyrogonite with tapering ends; 12 to 13 spirals are visible in lateral view, strongly concave with segmented basal plate shallow pit bordered by truncations at base of the spiral cells.

**Measurements:** Height = 610 - 963  $\mu\text{m}$  & Width = 490 - 540  $\mu\text{m}$ .

**Materials:** Five complete, well preserved specimens and three crushed ones are recorded.

**Remarks:** The specimens under consideration demonstrate a great resemblance in shape, dimensions, and spiral cells to the holotype originally figured and described by Feist and Grambast-Fesard (1984) under the name of *Musacchiella douzensis*. This species is distinguished generally by its concave spiral cells that become slightly convex in the middle part of gyrogonite.

**Occurrence:** This species has been recorded from the Middle Jurassic (Bathonian) of France by Feist and Grambast (1984). However, it was reported also from Late Jurassic of Germany (Mädler, 1986). In the present material, this taxon was recorded

from samples, WR. 1, 2, 3, and 4 from the lower part of Wadi Ar Rajban section. (Fig. 2).

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*Porochara maestratia* Martin-Closas and Grambast, 1986.

(Pl. 1, Fig. 10 A & B)

**Description:** Gyrogonite ellipsoid to subspherical, six to seven spirals are visible in lateral view, pentagonal basal pore, apical pore subpentagonal and relatively small, bordered by spiral cells.

**Measurements:** Height = 480 - 692  $\mu\text{m}$  & Width = 560 - 630  $\mu\text{m}$ .

**Materials:** Seven complete, well preserved specimens and four crushed ones are observed in the studied material.

**Remarks:** This taxon was originally described from the Early Cretaceous deposits of Spain by Closas and Grambast (1986) and shows great similarity to *Porochara douzensis* Feist and Grambast (1984) but differs in the dimensions and number of spirals.

**Occurrence:** This species was recorded from samples WR 2, 3 and 4. It also has been recorded from the Early Cretaceous of Spain (Martin - Closas & Grambast, 1986).

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*Porochara palmeri* Feist and Grambast, 1984 .

(Pl. 1, Figs. 11 A & B)

**Description:** Gyrogonite ellipsoid with tapering ends, especially near the apical and basal ends. Nine to ten concave to plane spirals are visible in lateral view. Segmented basal plates nearly on a level with the basal pore which is small and surrounded by sutures.

**Measurements:** Height = 250 - 620  $\mu\text{m}$ . & Width = 210 - 490  $\mu\text{m}$ .

**Materials:** Three well preserved specimens and two crushed ones are observed.

**Remarks:** The specimens under observation show great resemblance in shape, number of spirals and dimensions to the holotype as figured and described by Feist and Grambast (1984). This taxon differs from *Porochara douzensis* by its more dumpy shape, smaller dimensions and the conformation of the basal region.

**Occurrence:** This taxon was recorded from the lower part of the Wadi Ar Rajban section especially in samples WR. 1, 2 and 3. It has been recorded from the Middle to late Jurassic (Bathonian to Kimmeridgian) deposits of England by Feist and Grambast (1984). Also it is reported from Late Jurassic deposits of Germany by Feist and Schudack

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*Porochara* sp. A.

(Pl. 1, Figs. 12 A)

**Description:** Gyrogonite ellipsoidal with eight to nine concave spirals in lateral view; the basal plate is not visible from the outer side of gyrogonite.

**Measurement:** Height = 240 - 530  $\mu\text{m}$ . & Width = 210- 480  $\mu\text{m}$ .

**Remarks:** The material under consideration is represented by small slightly crushed specimens in a relatively poor state of preservation that prevents the specific attributions.

**Occurrence:** These specimens were recorded from samples WR 2, 3 and 4 in the lower part of the studied section.

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*Porochara* sp. B.

(Pl. 1, Fig. 14 )

**Description:** Gyrogonite ovoidal with flat summit and tapering base, six to seven spirals are visible in lateral view with slightly concave surfaces. Small apical and basal pores.

**Measurements:** Height = 680 - 723  $\mu\text{m}$ . & Width = 447 - 510  $\mu\text{m}$ .

**Material:** Three well preserved specimens and two badly preserved ones are observed.

**Remarks:** The presence of an apical pore in the top of the gyrogonite strongly emphasizes that this taxon belongs to the family *Porocharaceae*. The few specimens recorded in the studied material prevented identification to the species level. However, detailed examination of the basal plate, inside the gyrogonite may permit precise identification in the future.

**Occurrence:** This taxon was recorded in samples WR. 6, 8, and 11

### Age assignment

The age assignment of the Ar Rajban Member of the Kiklah Formation has not been settled and has become controversial because of the absence and scarcity of diagnostic macro- and microfauna index fossils. An Early Cretaceous age was assigned to the entire Kiklah Formation by numerous authors (Sassi, 1942; Christie, 1955; Burolet, 1960; Desio *et al.* 1963; Goudarzi, 1970; Assereto and Benelli, 1971; Barr and Weeger, 1972). Conversely, Hinnawy and Chesitev (1975) assigned this member to Post-Oxfordian and Pre-Cenomanian, most probably to Late Jurassic age. Novovic (1977), on the basis of palynological studies, reported three horizons containing numerous pollen and spores. He indicated that the Ar Rajban Member of the Kiklah Formation had an age ranging from Late Jurassic to Early Cretaceous. The present study demonstrates that the upper part of the Ar Rajban Member yielded a charophyte assemblage, represented by *Atopochara trivolvis trivolvis*, *Flabellochara harrisi*, *Lamperothamnium cylindricum*, and *Platychara grambastii*, of definitely Early Cretaceous age. However, the lower part of the section contains numerous charophytes of typically Late Jurassic age in the form of *Porochara douzensis*, *Porochara palmeri*, *Porochara maestratica* and *Porochara anluensis*. The co-occurrence of the previously mentioned species shows that Ar Rajban Member is ranged in age from Late Jurassic to Early Cretaceous. It is also noteworthy that the ostracod associated with the whole charophytes assemblage at Wadi Ar Rajaban locality are mainly of fresh water species represented essentially by: *Cytherella* sp., *Bythocypris* sp., *Cythereis* sp. and *Cytheropteron* sp. Plant remains including silicified woods, are fairly common in this member, further supporting the lacustrine associated facies.

### Summary & Conclusion

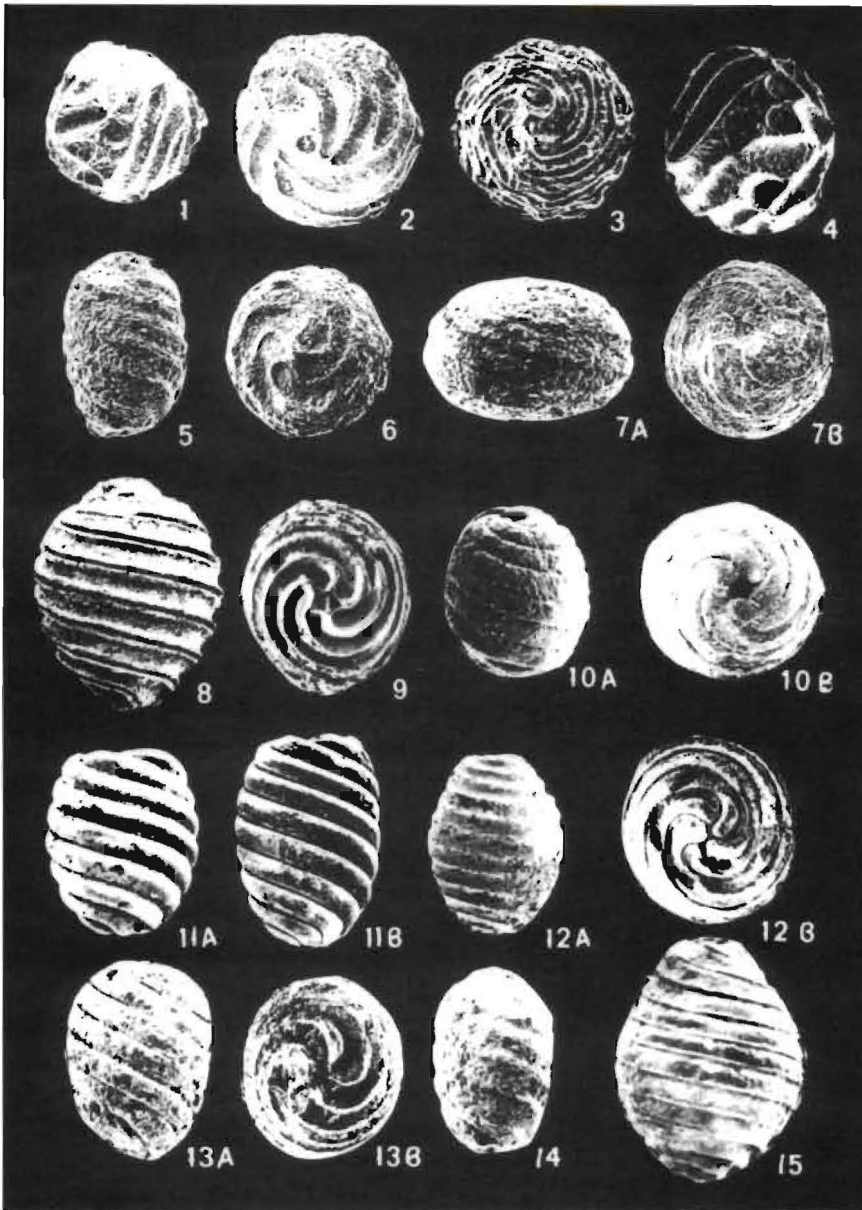
One measured section has been taken from Ar Rajban Member of Kiklah Formation at Wadi Ar Rajban, Mizdah area, northwestern Libya. The rock samples collected (twelve samples) were treated for their charophyte content. The obtained charophyte assemblage were identified, described and figured for the first time in the study area. The study resulted in the identification of 11 charophyte species belonging to 6 genera and 3 families where

the systematic work of the identified species are based on the work of Peck (1957) and Grambast (1974) as well as the recently modified classification proposed by Schudack (1986 & 1993). The study reveals also that the well preserved charophyte assemblages are closely associated with the sandy to argillaceous limestone and calcareous siltstone samples. The lower part of the section yielded a charophyte assemblage that includes *Porochara douzensis*, *P. plameri*, and *P. maestratica* of typically Late Jurassic age. On the other hand, the upper part yielded assemblages containing *Atopochara trivolvis trivolvis*, *Flabellochara harrisi*, *Lamperothamnium cylindricum*, *Sphaerochara* sp. and *Porochara anluensis* of definitely Early Cretaceous age. Paleoecologically, the recorded charophyte assemblages strongly indicated that the Ar Rajban Member was deposited under a lacustrine (fresh water) environment and represents ages from the Late Jurassic to the Early Cretaceous.

### Acknowledgment:

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**Plate. 1**

(All the figured specimens are magnified as X 50 unless otherwise noted)

Fig. (1): *Atopochara trivolvis trivolvis* Grambast. Lateral view of the utricle, sample No. 9.

Fig. (2): *Atopochara trivolvis trivolvis* Grambast. An apical view of the utricle, sample No.11.

Fig. (3): *Flabellochara harrisi* (Peck ). Lateral view of the utricle with spirals, sample No.11.

Fig. (4): *Flabellochara harrisi* (Peck). Apical and dorsal views, sample No. 12, X 60.

Figs. (5, 6): *Lamprothamnium cylindricum* (Peck ). (5): Lateral view of the utricle . (6): Apical view of the utricle showing preserved apical structure, sample No. 10, X 60.

Figs. (7A & 7B): *Platychara grambastii* Peck and Forester. (7A): Lateral view, (7B): Apical view, sample No. 10, X 60

Figs. (8 & 9): *Porochara douzensis* Feist and Grambast-Fessard. (8): Lateral view (9): Apical view, sample No. 4.

Figs. (10A & 10B): *Porochara maestatica* Martin-Closas and Grambast. (10A): Lateral view, (10B): Apical view, sample No.3.

Figs. (11A & 11B): *Porochara palmeri* Feist and Grambest. Lateral views, sample No. 4.

Figs. (12A): *Porochara sp. A.* Lateral view, sample No. 4.

Figs. (12B): *Sphaerochara sp.* Apical view, sample No.10.

Figs. (13A & 13B): *Porochara anlunesis* Wang. (13A): Lateral view, (13B): Basal view, sample No.10.

Fig. (14): *Porochara sp. B.* Lateral view of the utricle, sample No.6.

Fig. (15): *Porochara douzensis* Feist and Grambast-Fessard. Lateral view, sample No.3, X 60.

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