Microfossils (Foraminifera and Calcareous Algae) of the Yamama Formation, Southern Iraq

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Abstract

The Yamama Formation is one of the important reservoirs, in southern Iraq. This formation in all studied wells consists of limestone and dolomitic limestone. Microfacies analysis clarified that the formation represented a ramp, inner, middle and outer environments, seventy-one species are recorded, the main fossils are composed of many genera and species related to main groups such as foraminifera, calcareous algae, and stromatoporoids with few occurrences of gastropods, bivalves, bryozoans, spiculites and Echinoderms. The study has recorded 6 genera of foraminifera and 11 genera (green algae), 3 species related to Salpingoporella sp., 2 genera related to red algae, 1 genera related to Charophytes (nonmarine plants) for the first time in the Yamama Formation.

Keywords: Microfossils; Yamama Formation; Systematic; Foraminifera; Calcareous algae; Southern Iraq

1. Introduction

The Yamama Formation was first described in the Mesozoic Rocks in Saudi Arabia. The formation was found through the carbonate-dominated rock, where overlaps with the Sulaiy Formation (Sadooni, 1993; Jassim et al., 2006) in addition, the formation appear in Early Cretaceous depositional cycle. The cycle is represented many subsurface formations Southern Iraq Yamama Formation is also conformable with overlying and underlying Ratawi and Sulaiy formations respectively (Buday, 1980). The formation is divided into rock units composed of limestone and argillaceous limestone separated by barriers (Sadooni, 1993). Deposits Yamama platform were represented intrashelf basins of the Arabian Plate with New-Tethys Sea beginning in the first sequences of the Early Cretaceous. Digeneric processes and tectonism were affected on reservoirs quality properties, (Lucia, 2003; Ahr, 2008; Moore, 2014). In general, microfacies are a primary tool controlling framework and dimensions of pores in hydrocarbon rocks. However, in reservoirs, changes of properties are related to the effect of digenesis (Mazzullo, 1994; Moore, 2014).

The Yamama Formation is younger than the Sulaiy Formation with conformable contact boundaries. Yamama Lower Cretaceous age consist of limestone, argillaceous limestone and contains small benthic foraminifera. Yamama Formation overlying by the Ratawi Formation. Heterogeneity influences were recognized in the Ratawi Formation by package of dirty limestone and clastic rocks. Argillaceous limestone of Ratawi Formation can be represented as a seal rock of the Yamama Formation

DOI: 10.46717/igj.55.1E.10Ms-2022-05-26
Cretaceous third-order cycle (Sharland et al., 2001) (Fig. 1). Upper part of this cycle contains inner-ramp oolitic and grainstone facies gradational into wakestones packstone-middle-ramp facies, consist of fine grains peloidal, and coral Stromatoporoid bioclastics (Sadooni, 1993). The study area includes selected wells in several fields (Fayhaa-Sindbad-Siba-Zubair, Ratawi and West Qurna) distributed in Southern Iraq (Table 1), (Fig. 2).

Fig. 1. Sequence stratigraphy of the Cretaceous age (Sharland et al., 2001)

Fig. 2. Location map of the study area (Jaffar, 2018)
Table 1. Coordinates of the studied wells

<table>
<thead>
<tr>
<th>Field name</th>
<th>Well No.</th>
<th>Easting</th>
<th>Northing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Siba</td>
<td>Sb-6</td>
<td>2216000</td>
<td>33687000</td>
</tr>
<tr>
<td>dbad</td>
<td>Snd-3</td>
<td>786740</td>
<td>3390730</td>
</tr>
<tr>
<td>Fayhaa</td>
<td>Fh-2</td>
<td>215502</td>
<td>3432609</td>
</tr>
<tr>
<td>Ratawi</td>
<td>Rt-5</td>
<td>700000</td>
<td>3392200</td>
</tr>
<tr>
<td>West Qurna</td>
<td>WQ-203</td>
<td>714500</td>
<td>3434750</td>
</tr>
<tr>
<td>Zubair</td>
<td>Zb-47</td>
<td>758523</td>
<td>3361470</td>
</tr>
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</table>

Several studies have been made different considerations about delineation of the Yamama chronostratigraphy, this impression relates to wide propagation of foraminifera. (Buday, 1980), indicated that Yamama Formation was deposited during the Valanginian in Ratawi-1. (Razoian suggested the Valanginian age of the formation depending on *Pseudocyclammina lituus*, *Trocholina elongata* and *Anchispirocyclina* sp. (Al-Sharaa, 2004) indicated, that the Yamama Formation was deposited in late Berriasian-Early Hauterivian in Amara Field. The main objective of the study includes: Diagnosis of fossils foraminifera and calcareous algae, and the possibility of identification in thin section, enhance their potential for use in biostratigraphy, paleoenvironment interpretations and paleogeographic comparisons.

2. Materials and Methods

Methodology was concentrated on thin sections provide from Basrah Oil Company. Six wells were selected from six fields (Fh-2, Snd-3, Sb-6, Rt-5, Zb-47, and WQ-203). 409 thin sections were prepared by Laboratories of Basrah Oil Company (Geology and Control Geology Department). This stage which included paleontological and petrographic study by Binocular Microscope (Plates 1, 2 and 3).

2. Geological Setting

2.1. Stratigraphy

The type section of the Yamama Formation outcrops in Saudi Arabia where it was described as fragmental limestone units (Steineke and Bramkamp, 1952). Limestone and dolomitic are the main lithology of this formation (Fig. 3). Deposits Yamama platform was represented intrashelf basins of the Arabian Plate. They refer to the first depositional sequences of the Early Cretaceous third-order (Sharland et al., 2001). Cycle top was represented inner-ramp facies that transition into small size of peloidal facies and wackestone/packstone, coral/Stromotoporoid bioclastic were deposited on middle-ramp (Sadooni, 1993).

Bases cycle of outer-ramp consist of compact grey chalky limestone cycle (YR–A, -B, -C) and bases (YB-1, -2) represent late highstand and transgressive early highstand system tracts. The uppermost facies are pinkish and grey micrites which are locally chalky or contain thin, inter bedded calcarenites, Lower unites are dominantly calcarenitic and oolitic (Roychoudhury and Handoo, 1980). At Nasiriya, west Qurna, Majnoon and Ammara fields, the sequence boundaries have been identified within the Yamama Formation at the top of oolite facies (Godet et al., 2008).

2.2. Structural and Tectonic Setting

Location of the study areas is the south part of Iraq in the Zubair subzone depending on Iraq tectonic classification (Jassim and Goff, 2006). Tectonism effecting on Yamama basin. There are three subzones: The Zubair, Euphrates and Tigris Subzones. The Euphrates subzone contains synclines and narrow anticlines. It is mobile unit of the Mesopotamian zone accompanied by long normal fault. Extensional
forces in the Early Cretaceous caused rifting and tectonic movements in turkey and north of Arabian plate, this tectonic movements starting at the beginning or the Early Cretaceous, and it is formed Yamama basin in the Berriasian -Valanginian. Arabian plate was influenced by tectonism that caused rifting was occurred around margins during tectonic cretaceous history. (Koop and Stonely, 1982).

Fig. 3. Stratigraphic column of the Yamama Formation in FH-02 (Taha, 2020)
3. Results

3.1. Systematics of microfossils

Seventy-one species of many fossiliferous group were recognized related to 42 species from 31 genus related to benthic foraminifera, 1 genus of planktonic foraminifera, 27 species from 23 genus related to Chloropyta, 2 species from 2 genus related to Redophyta, 1 genus of corallin red algae, 1 genera of Stromatoporids, other fossils (spicules of demosponge, molluska, ostracoda, and echinodermata) (Cushman, 1928), (Loeblich and Tappan, 1964), (Banner and Highton, 1990). Systematics of foraminifera depending on references such as Cushman (1948), Loeblich and Tappan (1964), Banner & Highton (1990), Boudgher-Fadel (2008), Systematic of calcareous algae depending on Elliott (1965); Basson and Edgell, 1971; Bucur (2012); Scholle (2003).

3.1.1. Foraminifera

Family: Lituolidae
Subfamily: Lituolina
Genus: Pseudocyclaminina
Species: Pseudocyclaminina lituus, (Plate 1)

3.1.1.1. Description & remarks

The test is planispirally enrolled, subspherical to flattened, involute at least in the early stage and later uncoiling (Loeblich and Tappan, 1964). It is common in the Valanginian-Hauterivian.

Family: Cyclamminidae
Subfamily: Buccicrenatinae
Genus: Everticyclammina
Species: Everticyclammina kelleri

Everticyclammina kelleri. Description Test made of microgranular, imperforate calcite with agglutinated, scattered, fine-silt size, quartz and other exotic grains; planispirally coiled, involute, with umbilical overlap of successive chamber-walls, so that the umbilical areas become thickened and convex and the test becomes subrhombic in axial section.

Family: Cyclamminidae
Genus: Hemicyclammina sigali
Species Hemicyclammina sigali

Tests are planispiral, with a single aperture occupying all, or nearly all, of the total height of the apertural face in equatorial section, reducing the solid septa which are clearly different in structure from spiral wall. The basal layer is deposited over the chamber floors. Cretaceous (Late Aptian to Early Cenomanian)

Family: Chrysalidinidae
Subfamily: Chrysalidininae
Genus: Chrysalidinia
Species: Chrysalidinia intracretacea Sinni, 1979

Tests are high trochospiral, with quadriserrial, or biserial coiling modes, or with certain consecutive pairs of these. The aperture is central along the axis of coiling.

Family: Lituolidae
Subfamily: Lituolinae
Genus: Trocholina
Species Trocholina elongatae
Trocholina may be conical, plano-convex or lenticular in shape. It consists of a globular proloculus followed by a trochospirally enrolled undivided tubular second chamber around a solid core of pillars, filling the umbilical area. The aperture is at the end of a tubular chamber around a solid core of pillars, filling the umbilical area. The stratigraphical range includes Bathonian – Cenomanian interval.

Family: Trocholinidae  
Genus: **Coscinoconus**  
Species: **Coscinoconus**

It is characterized by reduced lamellae on the spiral side. The aragonitic test is low to high trochospirally coiled, proloculus followed by second chamber. The stratigraphical range includes Bathonian – Cenomanian interval.

Family: Choffatellidae  
Genus: **Choffatella**  
Species: **Choffatella decipiens**

The test is planispiral, but the early part may be streptospiral, lacking continuously developed endoskeletal pillars. Early Jurassic (Pliensbachian) to Late Cretaceous (Coniacian).

Family: Valulinidae  
Genus: **Cuneolina** (Plate 2)

Slightly eccentric and oval; up to twelve biserial arcuate concentric chambers expand from apex; chambers divided into chamberlets Stratigraphic distribution: Late Valanginian-Hauterivian

Family: Nautiloculindae (Loeblich and Tappan, 1985)  
Genus: **Nautiloculina**  
Species: **Nautiloculina Oolithica**.

Debate on the wall type (whether the wall is microgranular or porcelaneous) gave rise to placement of this genus into different taxonomic levels (into miliolines by Loeblich & Tappan (1964) and Boudagher-Fadel (2008): *Nautiloculina Oolithica* was described by Sampo (1969) in Iran as Late Jurassic – Berriasian.

Family: Alveolinidae  
Genus: **Praealveolina** sp.  
Species: **Praealveolina** sp.

Freetest, it is large, appears in different shapes, its coiling planispiral, fusiform, subcylindrical, and ovate, coiling along elongate axis. Early whorls may be irregular, streptospiral in monomorphic species, and may be seen in microspheric forms in dimorphic species. Early Cretaceous.

Family: Charentiidae (Loeblich and Tappan, 1985)  
Genus: **Charentia** (Neumann, 1965)  
Species: **Charentia cuvillieri** (Neumann, 1965)  
from the Lower-Middle Cretaceous in thrust folded Zonet. The typall-area of *C. cuvillieri* is recorded at Upper Cretaceous in western France (Neumann, 1965). *C. cuvillieri* is found at the Hauterivian at the same time big size morphotypes found essentially in Cenomanian strata.

Family: Ventrolaminidae  
Genus: **Protopeneroplis**  
Species: **Protopeneroplis ultragranulata**

*Protopeneroplis ultragranulata* Gorbatchik its coiling trochospiral, it differs from another species. Geologic time from Late Jurassic to Early Cretaceous. This species has diversity from latest Jurassic to Early Cretaceous.

Family: Hauerinidae  
Genus: **Nummolculina** IRK sp.  
**Nummolculina** IRK sp.
Test is composed of Porcelaneous calcite, having an oval outline. Coiling, thickening in wall, it is characterization of cross sections.

Family: Hauerinidae
Genus: Pyrgo sp. (Plate 2)

Porcelainous test has oval outline. Involute is *quinqueloculine*. It has a keel-shaped. It is characteristic in cross sections, at the periphery of the test.

Family: Miliolidae
Genus: Quinqueloculina
Species *Quinqueloculina* sp.

Porcelainous test has oval outline. This genus *Quinqueloculina* contains many species having high morphological test, involute that is coiling axis shift 72° in each half of coiling resulted in 144° gap between successive chambers in transverse sections.

Family: Hauerinidae
Genus: *Moesiloculina* spp.

Porcelainous test has oval outline. Coiling is *quinqueloculine*. It is recognized by its elongate shape.

Family: Hauerinidae,
Genus: *Istriloculina* sp.

*Istriloculina* possesses an elliptic up to high elliptic-elongate thin test.

Genus: *Triloculina* sp.
Species: *Triloculina* sp.

The most characteristic feature of this genus is the thin porcelainous wall. The coiling is Triloculin in the early stage, later pseudotriloculine to biloculine. The individuals of this genus were identified from the Tithonian – Berriasian.

Family: Hauerinidae
Genus: *Austrotrillina* sp. (Plate 2)

The wall structure of this genus is composed of porcelainous calcite. The individuals of this genus were identified from the Tithonian – Berriasian

Family: Vaginulinae
Subfamily: Lenticulindae
Genus: *Lenticulina* sp.

The wall is hyaline calcareous structure. The test is, coiling planispiral and involute with a swollen lentil like overall shape. The periphery is pointed.

Family: Rotaliidae
Genus: *Rotalia*
Species: *Rotalia skourensis* (Plate 2)

The structure of wall is composed of hyaline calcite. It’s coiling planispiral. It is found in the Early Cretaceous-Late Cretaceous. Stratigraphic geologic time: Early Cretaceous

Family: Textulariidae
Genus: *Siphovalvulina*

Test is finely agglutinated, coiled trochospirally. This genus is characterized by two siphonal canal feature that leave travel the test and its tightened with apertures. Stratigraphic geologic time: Upper Jurassic-Lower Cretaceous

Family: Mayncinacea (Neumann, 1965)
Genus: *Mayncina* (Neumann, 1965)
Species: *Mayncina bulgarica*
distinguished by its discoidal to lenticular shape test, with numerous broad and low chambers; coiling is planispiral and the operculinoid spire increases slowly in height, it has a numerous septum separating the chambers. Stratigraphic geologic time: Lower Cretaceous.

Family: Hedbergellidae (Loeblich and Tappan, 1961)
Sub Subfamily: Hedbergellinae (Loeblich and Tappan, 1961)
GENUS: *Hedbergella*

*Hedbergella* spp.

Globular test, its coling low trochospiral with enlarge size chambers gradually. Umbilicus is narrow on the umbilical side, radial septum, depressed; Stratigraphic geologic time: Early-Middle Cretaceous, McMillan (1990).

3.1.2. *Calcareous algae*

Kingdom: Plant
Phylum: Thallophyta
Class: Chlorophyceae
Order: Dasycladales
Family: Triploporellaceae
Genus: *Salpingoporella*
Species: *Salpingoporella carpathica* (Plate 2)

Small, unbranched, cylindrical thallus, visibly segmented. The walls of the thallus are thick and well calcified. In transverse section, the thallus has a calcified. Found in the Barremian of the Carpathian region of Roumania and the Lower Aptian of Lebanon.

Family: Triploporellaceae
Genus: *Salpingoporella*
Species: *Salpingoporella muehlbergii*

Laterals set in quincunxes, 5-11 per verticil, horizontal (sometimes slightly leaning up), first with a narrow tubular proximal part, then widening out, circular, rhombic or irregular in section. Distribution: Western and Eastern Europe. Upper Barremian – Lower Aptian

Family: Triploporellaceae
Genus: *Salpingoporella*
Species: *Salpingoporella* aff. *S. hasi*

Family: Triploporellaceae
Genus: *Salpingoporella*
Species: *Salpingoporella, milovanovici*

This species is small in dimensions. *Salpingoporella, milovanovici* RADOIČIĆ is frequently in thin sections having other larger family of calcareous algae.

Family: CodiaceaeTrevisan
Genus: *Pianella*
Species: *Pianella dinarica*

Cylindrical shape, segmented thallus was visible; minimum length 2.8 mm. in minimum, external diameter 0.25-0.58 mm. thallus branches are horizontally arranged in alternating whorls, are funnel-shaped, and are few in number per whorl. *dinarica* is a characteristic Lower Cretaceous, Barremian and Aptian.

Family: Dasycladaceae
Genus: *Actinoporella*
Species: *Actinoporella podolica* Alth (Plate 2)
Thallus was thick, cylindrical shape, alittle turned, essential branches orderly arranged in whorls. A bunchy calcite tube generally casing in each branch, segment of tubular rays 0.08-0.09 mm. Statigraphic range is Late Jurassic Early Cretaceous. In Lebanon Actinoporella podolica is found in Late Jurassic to Late Aptian strata.

Family: Codiaceae Trevisan
Genus: Lithocodium (Elliott, 1956)
Species: Lithocodium aggregatum (Elliott, 1956) (Plate 3)

This plant is distinguished by crust contain micritic that bears cavities along it that appears look like alveolar structures. Depending on previous studies Lithocodium aggregatum is mostly occurrence with Troglotella incrustans and bacinellid structures. This species was recorded from the Upper most Jurassic-Lower Cretaceous.

Family: Triploporellaceae
Genus: Dissocladella
Species: Dissocladella undulate

It has cylindrical shape, with eight primary funnel branches and six secondaries Dissocladella undulate was found in Lower-Middle Cretaceous strata of Zagros Mountains.

Family: Dacycladalceae
Genus: Cylindroporella (Johnson, 1954)
Species: Cylindroporella sugdeni (Elliott, 1975)

Articulated thallus consisting of large, thick, cylindrical segments. Relatively narrow central canal usually contains six big size of sporangia around it which alternate with primary branches in primary stage. Diameter of cylinder 0.60-1.06 mm. diameter of central canal 0.14-0.24 mm. diameter of sporangium 0.1 6-0.18 mm. number of sporangia per whorl six. This distinctive species is also known from the Lower Cretaceous of Hadhramaut and Israel, and the Hauteri-vian of Iraq. C. sugdeni occurs in the Upper Aptian of Lebanon.

Family: Udoteaceae
Genus: Arabicodium (Elliott, 1957)
Species: Arabicodium texana (Elliott, 1957)

This species is recognized by wide medullary zones with alitle ripply, it has longitudinal threads nearby similar diameters in the centric and cortical zones (in contrast to Halimeda). Arabicodium sp. Predominaingly recognized with fragments of A. aegagrapiloides (Elliott, 1957), the last is distinquished by great dimensions and additional thick fabri structure of the cortical tubes. Arabicodium sp. was found in Late Albian limestones (Bucur, 2012)

Family: Dacycladalceae
Genus: Clypeina (Plate 3)

This species is 0.27 mm. in maximum diameter, test composed of calcite, may be showing sporangial chambers around a central tube, diameter is 0.10 mm. In spite of the segment’s specimen figured does not identify in stratigraphic horizon with C. parvula Elliott, it agrees with the specimens figured by Elliott (1968) in morphological features.

Family: Dacycladalceae
GENUS: Trinocladus
Species: Trinocladus tripolitanus (Plate 3)

Thallus of Trinocladus tripolitanus Raineri, has Cylindrical or paddle shaped with primary branches, the primary gloubular fill 1 and ½ of the wall. The observation of length up to 5.5mm in maximum agree with additional diameters (D) from 0.75 to 1mm; intra diameters vary from 0.15 to 0.2mm. This species is found in Lower Cretaceous in Zagros thrust folded zone and. T. tripolitanus was found from Upper Cretaceous in North Africa.
Family: Dacycladalceae
Genus: *Heteroporella*

The characterization of the *Heteroporella* is cylindrical shape with 2 types of sterile and fertile branches in alternating independent whorls. *Heteroporella* was recorded in the Lower Cretaceous beds of Zagros folded zone.

Family: Dacycladalceae
Genus: *Mastopora*

Plants represent early stage of green calcareous algae. It is showing cortical cups arrangement in radial structure along the margin, without any structure of the wall. Infect, the, central cavity of this species filling with coarse grains of parry calcite. It is also found from Late Jurassic to Early Cretaceous Beds of other areas of Europe, and from the Late Jurassic and Valanginian of the Middle East.

Family: Dacycladalceae
Genus: *Acicularia* sp.

Segments of slightly curved calcareous spicules perforated by numerous rounded openings or as ovoid or circular disks perforated at or near the margin by numerous spherical sporangial cavities. This species was recorded as occurring from the Early-Middle Cretaceous of Italy. Its stratigraphic range in Italy was later given by the same author as Albian to Cenomanian.

Family: Dacycladalceae
Genus: *Coptocampylodon* (Elliott, 1963)
Species: *Coptocampylodon lineolatus* (Elliott, 1963)

Solid, short, cylindrical thallus varying from 0.19 to 0.42 mm. in diameter. Transverse sections are generally circular in cross section but deeply incised by parallel, equidistant, longitudinal grooves from five to nine in number. This species Found in the Early Cretaceous of Borneo and of the Middle East, especially Iraq. This species has been noted throughout the Aptian of Lebanon.

Family: Polyphysaceae
Genus: *Terquemella* sp.

The studied thin sections, were recognized many forms of this species such as spheroidal, ovoidal or discoidal corpuscles representing *dasyycladalcean* family. The previous studies to these plants contain a detailed information on their generic evolution. Now at Resent.

Family: Dacycladalceae
Genus: *Carpathoporella*
Species: *Carpathoporella occidentalis*

Simple, non-segmented, cylindrical thallus with a well-developed central canal. Verticils widely separated. Pores of a special type, flattened longitu- dinally, giving the appearance of longitudinal canals. Recently described from the Barremian of Roumania (Dragastan, 1969), this species is found rarely throughout the Aptian of Lebanon.

Family: Polyphysaceae
Genus: *Deloffrella* sp.
Species: *Deloffrella quercifoliipora* (Plate 13)

Thallus is small, cylindrical, contains four orders, has short branches laterals. This species in most time 2 or 3 orders of laterals’ branching are visible. Stratigraphic geologic time: Kimmeridgian-Upper Lower Barremian, Aptian unconfirmed.

Phylum: Charophyta
Class: Charophyceae (Plate 3)
3.1.2.1. Taxonomy and age range

Charophytes are plants related to one calcareous green algae group that apparently share a common ancestor with land plants; RNA and DNA analysis showed that charophytes are non-plant, and no evidence of land plants. Classical classification put these fossils in the Phylum Charophyta, and dismiss from other green calcareous algae by situation in the Class Charophyceae -Upper Silurian-Recent.

Family: Cymnodiaceae (Elliott, 1955)
Genus: *Permocalculus* (Elliott, 1955)
Species: *Permocalculus irenae* (Elliott, 1958) (Plate 3)

Fragments of segmented, cylindrical, irregular thallus. Pores visible at outer edge of fragments, about 0.017 mm. in diameter. Fragments of the thallus of this species are common in the Cenomanian and Albian of Iraq.

Family: Solenoporaceae
Genus: *Solenopora*
Species: *Solenopora liasica* (Le Maitre, 1937)

Colony 1.60 mm. in height, showing, in vertical section, vertical or slightly radiating, closely packed cell threads. Cross partitions separating cells in the threads are widely spaced or absent. Cell size in length not available; width of cells 0.044 mm. This species was mainly recognized from the Jurassic of Morocco by Le Maitre (1937). It is distinguished in the Late Jurassic beds of Lebanon.

Plate 1 A. *Pseudocyclammina litus* Yokoyama, Subaxial section, Rt-5, depth (3877.9) m.B. *Everticyclammina d kelleri* Henson., Subequatorial-equatorial section, Zb-47, depth (3969.60) m.C. *Choffatella decipiens*, Shlumberger, Equatorial section, depth (4107) m.D. *Trocholina elongatae* Paalzow, Axial section, Fh-2, depth 4134 m.
3.1.3. Corallin red algae

Family: Corallinaceae Lamourouxe
Genus: Lithophyllum
Species: Lithophyllum shebae (Elliott, 1959)

Sections of thallus 1.16-3.00 mm in diameter differentiated into central areas and marginal Lower Eocene. It has been found in the Upper Cretaceous (Cenomanian) strata of Lebanon.

3.1.4. Stromatoporoida

Taxonomy and Age Range: A group with uncertain affinities once grouped with coelenterates (and still thought by a few to be coelenterates), but today exceedingly may be related to demosponge. Phylum Porifera, Class Stromatoporoida-Lower Ordovician to Upper Devonian; Cretaceous. True stromatoporoids were highly current from Ordovician to Devonian. All latest shapes specific to the stromatoporoids are thought to have resulted from approximate revolution toward the stromatoporoid skeletal morphology.

Plate 2. A. Cuneolina SP., Orbigny, Vertical section, Rt-5, depth (3842.75) m. B. Rotalia skourensis Pfender, Transvers section, WQ-203, depth (3987.74) m. C. Austrotrillina sp. Neagu, Oblique axial section, WQ-203, depth (3984.82) m. D. Pyrgo sp. Yovcheva, Transversal section, Fh-2, depth (4260) m. E. Salpingoporella carpathica Dragstan, Longitudinal oblique, Fh-2, depth (4079.05) m. F. Actinoporella podolica (Alth), Longitudinal oblique section, Fh-2, depth (4260) m.
Plate 3. A. Clypeina Carozzi, transverse section, WQ-203. Depth (3990.90) m, B. Trincladus tripolitanus Raineri, transverse sections, Rt-5, Depth (3842.75) mC. Lithocodium aggregatum Elliott, Rt-5, depth (3841.95) mD. Deloffrella sp. Granier & Michaud, Longitudinal section, Rt-5, depth (3908.30) mE. Permocalculus irenae Elliott, Longitudinal section, Rt-5, depth (3810.90) m -F. Charophytes, Oblique section, Rt-5, depth (3882.09)

4. Paleoenvironments

Climate was a tropical during Cretaceous period over the Tethyan realm (Ward, 2006), which was the main increasing numbers of the larger foraminifera and mollusk bivalve. During the Lower Cretaceous, a very hot waters with hypersaline conditions favored the breeding of bivalve over comprises the stony corals (Kauffman and Johnson, 1988; Johnson et al., 1996). The fossils of the Yamama Formation occur in various facies. They abundant in warm water levels with dasyclad algae (Laporte, 1967; Conrad et al., 1975). Green calcareous algae (dasycladaceae) common, Actinoporella podolica is recognized in back reef environments. Dasyclad algae such as Clypeina sp., and stromatoporoids (Cladocoropsis lived in deepest water conditions than the larger foraminifera contemporaneous such as Everticyclammina. Their distribution extended into deeper water - outer ramp rich with argillaceous limestone, than Pseudocyclusminna sp. (This facies recognized in WQ -203., another similar conditions deepest-outter ramp of planktonic foraminifera Hedbergella sp. in Fayhaa -02-. They were succeeded under decrease of alumina, when red and green algae disappear. (Boudagher, 2008).
6. Microfacies Types and Depositional Environments

Investigating the lithofacies with examination of fossil associations of this formation resulted in identifying 5 main microfacies and 12 sub microfacies. According to analysis of bio and lithofacies, Yamama was represented ramp depositional model, (Fig. 4)

Regarding microscopic and core observations. (Embry and Clovan, 1972) main references were used to classify carbonate rocks.

Five main types of facies and twelve submicrofacies are determined:

- **Mudstone Microfacies**: It is divided into two submicrofacies
  - Foraminiferal-mudstone submicrofacies
  - Argillaceous lime mudstone submicrofacies
- **Wackestone Microfacies**: It is divided into four submicrofacies
  - Planktonic foraminiferal -lime wackestone submicrofacies
  - Foraminiferal -lime wackestone submicrofacies
  - Algal (desycladecan) Lime wacke submicrofacies
- **B-Spiculites/Calcspheres –Lime Wackstone submicrofacies**: Foraminiferal -Lime wackstone submicrofacies
  - Algal (desycladecan) Lime wacke submicrofacies
- **Packstone Microfacies**: It is divided into two submicrofacies
  - Bioclastic/Algal- lime packstone submicrofacies
  - Algal/Foraminiferal -algal -Lime packstone submicrofacies
- **Grainstone Microfacies**: It is divided into four submicrofacies
  - Peloidal poorly washed grainstone with bioclasts submicrofacies
  - Oolitic-Lithocodium aggregatum grainstone submicrofacies
  - Peloidal-intraclastic-, bioclastic grainstone submicrofacies
  - Intraclastic grainstone submicrofacies
- **Floatstone/ rudstone Microfacies**

The Yamama Formation in the studied wells indicates deposition in inner ramp (lagoon, restricted, open marine, shoal environments), middle and outer ramp. An analysis of the paleoecological significance of various species of algae in the Yamama Formation suggests that *Pianella dinarica* (Radoicic), *Actinoporella podolica* Alth, *Cylindroporella sugdeni* Elliott and *Lithocodium aggregatum* Elliott with larger foraminifera such as *Psedocyclammina* sp. were all characteristic of the intertidal and restricted shelf environment. Green calcareous algae (dasycladaceae) common, *Actinoporella podolica* is recognized in restricted environment especially in lagoon. Charophytes are non-marine green algae living on the bottom of ancient and Recent lakes and in other non-marine environments. which can be thought of as being phylogenetically between algae and vascular (land) plants (Grambast, 1974). Green algae such as *Clypeina* sp., and stromatoporoids (*Cladocoropsis*) and larger foraminifera such as *Everticyclammina* sp. and *Choffatella decipiens* Shlumberger occupied a deeper water palaeoenvironment (outer neritic) (Boudagher, 2008). In the other side (Red and coralline red algae) also common in Yamama Formation.Codiacean algae is likely to be distinguish in deeper depth. Limestone of reef origin contain big size bioclastics of the coralline algae and because of their ability to secrete calcium carbonate, these are associated with petroleum deposit (Basson and Edgell, 1971).
Fig. 4. Schematic model of carbonate ramp environments of the Yamama Formation depended on the facies association in study wells

5. Discussion

The Yamama Formation contains a wide variety of marine foraminifera and calcareous algae. These are consist predominantly of green algae (Chlorophyceae), which are most numerous in the Lower Cretaceous limestones. Species here identified as occurring in the Yamama Formation representatives of the families, Litouolidae, Cyclaminidae, Chrysalidinidae, Trocholinidae, Choffatellidae, Valulinidae, Dasyycladaceae and Codicaceae of the green algae, and Corallinaceae and Solemporaceae of the red algae.

The main fossils include larger foraminiferids such as Pseudocyclammina lituus, Everticyclammina kelleri HENSON, 3. Hemicyclammina sigali Maync, Chrysalidina intracretacea, Sinni, Chrysalidina gradata, Praechrysalidinia infracretacea, Pseudochrysalidina (Dukhania) conica (Sinni), Trocholina alpina LEUPOLD, Trocholina elongata LEUPOLD Trocholina altispira LEUPOLD, Trocholina conica LEUPOLD Trocholina lenticularis (Gollesstaneh) & Trocholina micra Sampo, Trocholina arabica HENSON, Choffatella decipiens Shlumberger, Rotalia skourensis, Septatropholina banner (Derin and Reiss), Coscinocupus, Cuneolina sp., d'Orbigny, Praealveolina sp., Reichel, Charentia cuvillieri Neumann, Nummolculina IRK sp., Pyrgo sp. Defrance, Protopeneropiis, ultragranulata Gorbachik, Okay & Altiner, Austrotrillina Neagu, Moesiloculina sp. Neagu, Triloculina Neagu, Triloculina sp., Siphovalvula Defrance Spiroplectammina biformis (Parker & Jones), Psedolituouella sp., Maynicina Bulgarla Laug Peybernes Rey, Natuliculina oolithica, Shlumbergerina sp. MOHLER, Quinqueloculina sp., Lenticulina sp. Lamarck, Textularia sp. And planktonic Hedbergella spp. d’Orbigny These are mixed with calcareouse algae such as Actinoporella podolica ALTH, Salpingoporella Carpathica RADOICIC, Salpingoporella
muehlbergii Lorenz, Salpingoporella milovanovici RADOIČIĆ, Salpingoporella hasi Conrad, Radoičić, Pianella dinarica Praturlon & Radoićić, Clypina sp Carozzi, Mastropora sp. Cros & Lemoine, Cylindroporella sugdeni ELLIOTT, Deloffrella sp. Granier & Michaud, Neomeris, cretacea STEINMANN, Trinocladus tripolitanus Raineri, Mastopora sp. (Cros & Lemoine, Nemeris mokragorensis) Radioićic & Schlagintwett, Dissocladella undulate Pia, Likanella daiiovae, Coptocampylodon lineolatus Elliott, Kopetdagaria sphærica Maslov, Lithocodium aggregatum ELLIOTT, Solenopora liasica Le Maître, Pianella dinarica - Praturlon & Radoićić, Arabicodium texana Elliott, Acicularia sp. endoi Praturlon, Heteroporella sp. Cros & Lemoine Ott, Terqumella sp. Munier-Chalmas ex Morellet and Morellet, Carpathoporella occidentalis Dragastan, Permocalculus irenae ELLIOTT, Lithophyllum shebae Elliott. The occurrence of numerous marine foraminifera and calcareous algae at many horizons in Jurassic and Cretaceous carbonate succession of Iraq is clear evidence that most of these strata accumulated under repeated shallow, warm-water, marine conditions. The study recorded 6 genera of foraminifera and 11 genera (green algae) ,3 species related to Salpingoporella sp. ,2 genera related to red algae, 1 genera related to Charophytes (non-marine plants) for the first time in the Yamama Formation, these are: (Foraminifera contains: Hemicyclammina sigali, Rotalia skourensis, Septatrocholina banner, Coscinoconus, Charentia cuvillieri, Protopeneprius ultragranulata Gorbatchik, Okay & Altner,(Green algae contains: Salpingoporella muehlbergii Lorenz, Salpingoporella milovanovici, Salpingoporella hasi Conrad, Pianella dinarica Praturlon, Clypina sp Carozzi, Mastropora sp. Cros & Lemoine, Deloffrella sp. Granier & Michaud, Trinocladus tripolitanus Raineri, Mastopora sp. (Cros & Lemoine, Nemeris mokragorensis Radioićic & Schlagintwett, Dissocladella undulate Pia, Coptocampylodon lineolatus Elliott, Kopetdagaria sphærica Maslov, Heteroporella sp. ,Cros & Lemoine Ott, Carpathoporella occidentalis Dragastan,(Red algae contains: Solenopora liasica Le Maître, Lithophyllum shebae Elliott, and Charophytes).

Charophytes were recorded for first time in the Ratawi-05. Charophytes are continental plants. They lived in fresh and, brakish water (Musacchio, 2000). Charophytes are widely used as one of the available groups of non-marine index fossils and used as paleoenvironmental tool (Grambast, 1974; Hasdrúbal et al., 2009). This case agreement with twelve to 14 sub-cycles may occur in Lower Cretaceous, bounded by Lowstands horizons containing plant remains (Aqrawi, 2010).

6. Conclusions

The Yamama Formation is rich with marine foraminifera and calcareous algae, these are active contributors to the building of the thick Cretaceous limestone. The study was recorded Charophytes (freshwater plants) is an emerging and largely unexplored field of paleobotany and indicator of non-marine environment. Microfacies analysis clarified that this formation was represented shallower conditions in many parts, (ramp carbonate setting), lagoon, restricted, open marine gradient to outer ramp conditions.

Acknowledgements

The authors acknowledge Basrah University for their support. They also acknowledge the Basrah Oil Company (Geology and Control Geology Department) and Dr. Kalid Habil for his valuable comments and supports. The authors are very grateful to the reviewers, Editor in Chief Prof. Dr. Salih M. Awadh, the Secretary of Journal Mr. Samir R. Hijab, and the Technical Editors for their great efforts and valuable comments.

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