Planktic Foraminiferal Biostratigraphy of the Upper Part of the Damlouk Member, Ratga Formation, Western Desert, Iraq

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ABSTRACT

The basinal part of the Damlouk Member upper sedimentary cycle of the Ratga Formation exposed in the Qaim area of the Iraqi western desert is examined. The studied section consists of marlstone, marly and phosphatic limestone, and planktic foraminifera-rich limestone beds. Detailed study of the planktic foraminiferal assemblages of these rocks revealed the occurrences of (30) species belonging to (11) genera. The stratigraphic distribution of these species permits the recognition of three biozones. These are from the lower to upper part of the section: - *Acarinina bullbrooki* Zone, (Middle Lutetian), *Morozovelloides lehneri* Zone, (Late Lutetian), *Globigerinatheca semiinvoluta – Hantkenina alabamensis* Zone, (Early Bartonian). These zones indicate that the studied section of the Ratga Formation (Damlouk Member) is of Middle-Late Lutetian to Early Bartonian age. These biozones are correlated with different local and regional studies.

Key words: Planktic foraminifera; biostratigraphy; Eocene; Ratga Formation; Iraq

الفورامنيفرا الطافية والطباقية الحياتية لجزء من العضو دملوق ضمن تكوين رتكة في الصحراء الغربية، العراق

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الملخص

يمثل البحث الحالي دراسة الفورامنيفرا الطافية والطباقية الحياتية لجزء من عضو دملوق التابع لتكوين رتكة في الصحراء الغربية - غرب العراق. تمثلت تتابعات التكوين بصخور المارل والحجر الجيري العائد لتكوين الرتكة المترسبة في بيئات بحرية عميقة. تم تشخيص (30) نوعا من انواع الفورامنيفرا الطافية تعود لـ (11) جنسا، واعتمادا على حشود الفورامنيفرا الطافية تم تحديد ثلاثة انطقة حيا تية ضمن مقطع الدراسة: النطاقان الاول والثاني يقعان ضمن الجزء الاسفل من المقطع بعمر الايو سين الاوسط، في حين حدد النطاق الثالث ضمن الايوسين المتاخر، وهذه الانطقة الحياتية هي من الاقدم في الاسفل الى الاحدث في الاعلى كالاتي: -

Acarinina bullbrooki Zone (Middle Lutetian)
Morozovelloides lehneri Zone (Late Lutetian)
Globigerinatheka semiinvoluta -Hantkenina alabamensis Zone (Early Bartonian)

الكلمات: الفورامنيفرا الطافية، الطباقية الحياتية، الأيوسين، تكوين رتكة، العراق.

INTRODUCTION

The Paleogene succession of the Western Desert of Iraq is an interesting sequence for two reasons; it includes the economically attractive phosphatic horizons of Iraq. The second reason is due to the stable tectonic situation of the area, which will preserve the Paleogene sequence as compared to the Arabian active plate margin of NE Iraq. Based on that interest, further study and understanding the origin and the history of this sequence are needed. This work aims to contribute to the revision of the chronostratigraphic framework of the Paleogene successions in the Western Desert. The stratigraphic description of the Paleogene sequence of the Western Desert is subject to active and detailed works by the geologists of the Geological Survey of Iraq to evaluate its potential mineral resources including phosphates and Uranium (Al- Mubarak and Ameen 1983; Hagopian 1979; Karim and Al-Bassam, 1997). These efforts followed the detailed work of (Bellen *et al.*, 1959) who had established the early stratigraphic subdivisions of the area. Followed by the work of (Al-Naqib, 1967) who had reviewed the general geology of the Western Desert. The work of (Hagopian, 1979) is considered an important stratigraphic contribution. He subdivided the Eocene Dammam Formation exposed at the edge of the western desert into five lithologic units based on lithostratigraphic characteristics. Extensive works of teams follow this attempt from the geological survey in detail to study the stratigraphic relations of the Paleogene phosphatic rich strata. The Eocene strata of the study area are considered now to be included in the Ratga Formation, which is introduced informally for the first time by (Jassim *et al.*, 1984; and Al-Bassam *et al.*, 1986). Karim and Al-Bassam (1997) gave the stratigraphic formal and detailed description of the Ratga Formation type section, which is subdivided into three lithologic members and they are from bottom to top as follows: Swab, Damlouk, and Mugur Members. Outcrops of these members are distributed along valleys such as Swab, Akashat, and Ratga, which are drained down towards the Ga'ara Depression to the southeast. The selected section of the Damlouk Member for this study is located along Wadi Akashat at the northwestern part of the Iraqi Western Desert, about 80 kilometers north of Rutba Town. The investigated area is called the Akashat area, which runs between 40° 00' and 40° 15' Long., and 34° 00' and 33° 45' Lat. (Fig. 1).

LITHOSTRATIGRAPHY

Karim and Al-Bassam (1997) formally describe the Ratga Formation of Lower-Upper Eocene age with details. It is geographically cropped out and distributed in the Western Desert with a thickness range between 200 - 220 m. This unit consists mainly of cyclic alternations of marl and marly limestone. The lower basinal unit of the pelagic marly limestone is often recognized as partly phosphatic, intensively recrystallized to chalky limestone with silicification as chert horizons and nodules. The upper unit is composed of shallow marine Nummulitic limestone variably intermixed with shelly bioclastic limestone. It is subdivided into three lithologic members from the bottom to the top: Swab, Damlouk, and Mugur Members (Fig. 2).

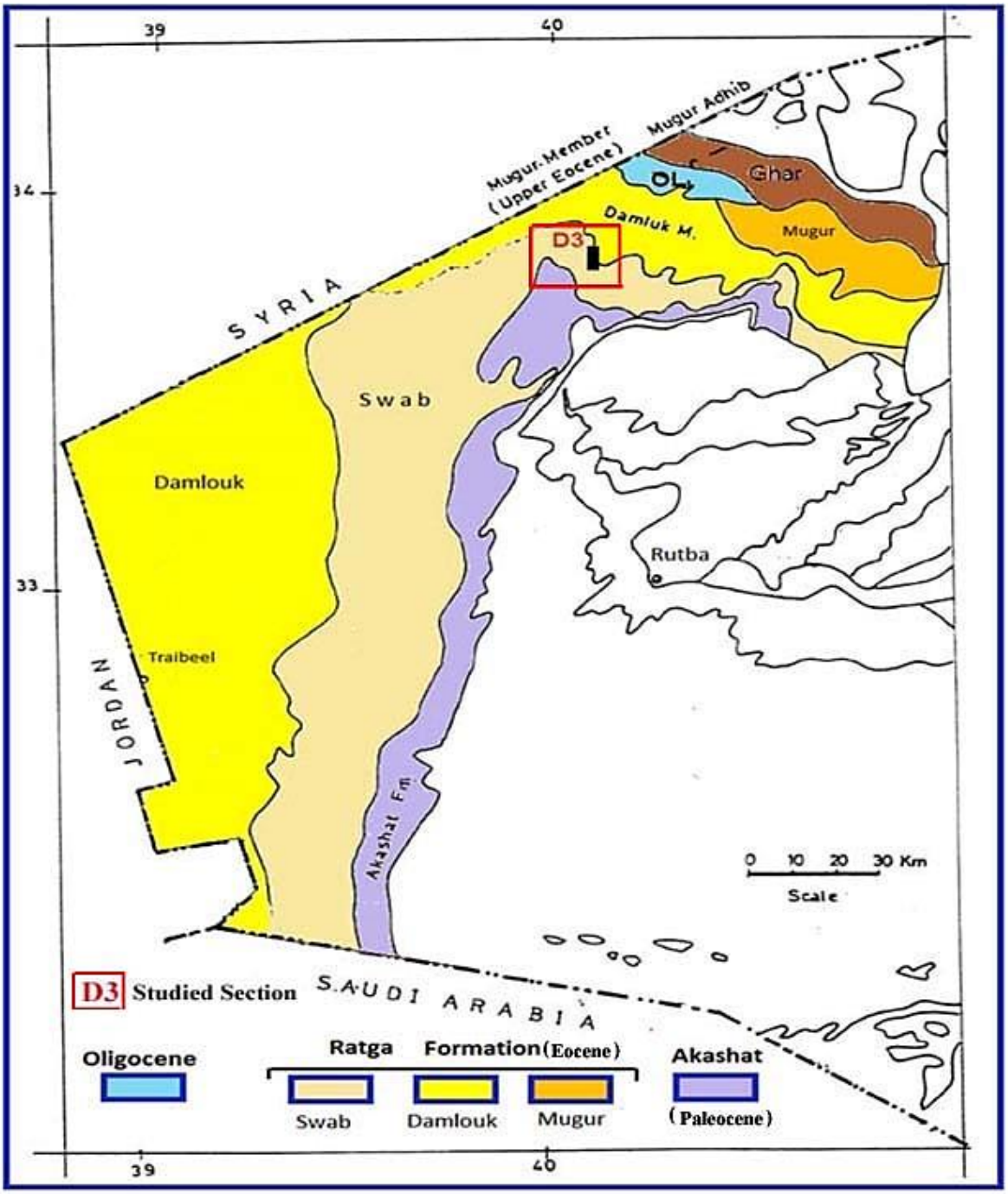

Fig. 1: Detailed geological map of the Ratga Formation at the Western Desert showing outcrop of its members and the location of the studied section (D3). (From Karim and Al-Bassam, 1997).

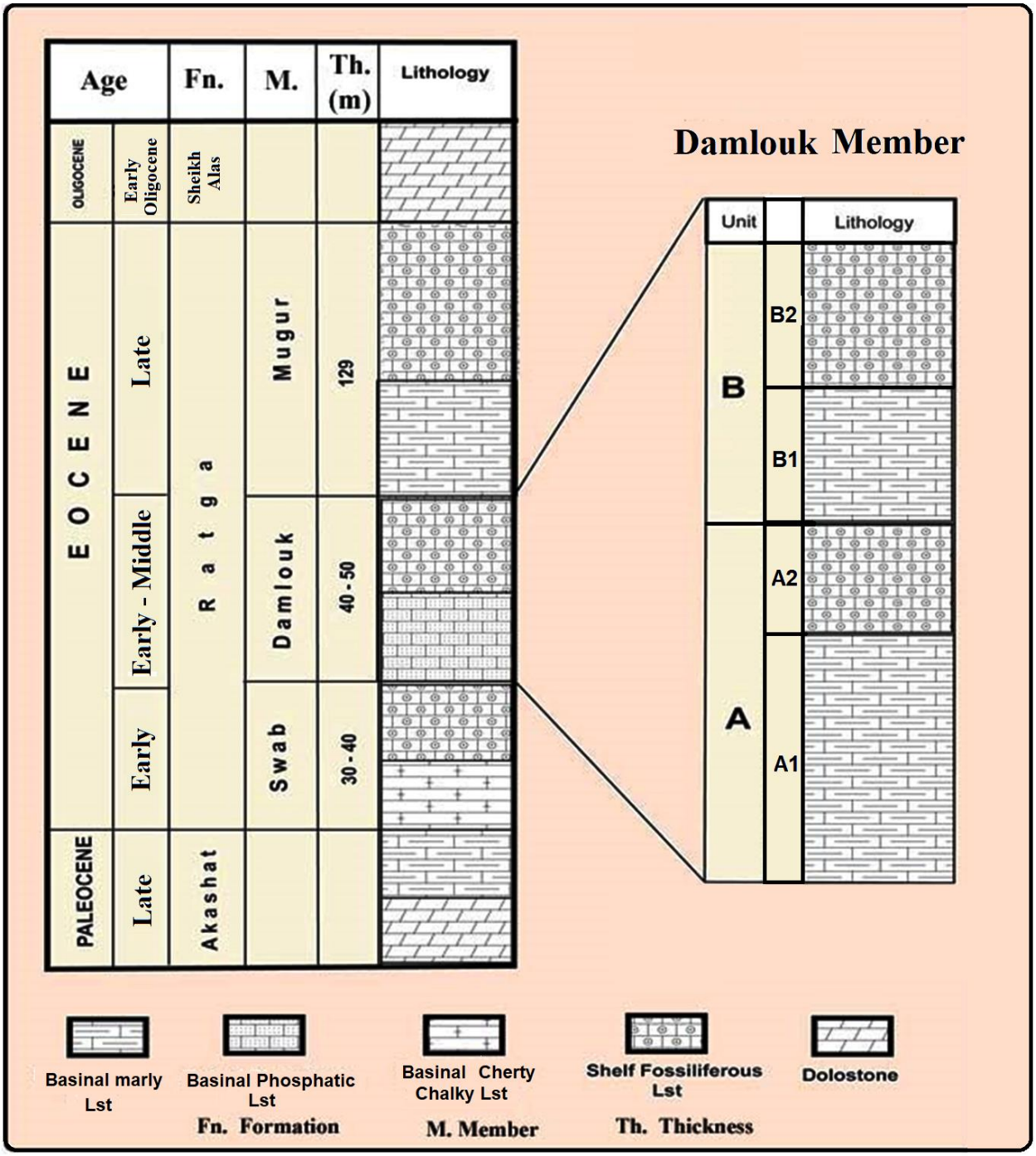

Fig. 2: Stratigraphic column of the Ratga Formation with detailed lithological characters of the Damlouk Member (Based on the description of (Al-Bassam, *et al.*, 1986; and Karim and Al-Bassam, 1997).

These members display cyclic alternations of similar lithologic units (described above). The Lower boundary is conformable with the Paleocene Akashat Formation. The upper boundary is also conformable with Sheikh Alas/ Shurau Formations of Lower

Oligocene age (Karim and Al-Bassam, 1997). The Damlouk Member is usually recognized with two distinctive cycles informally called Damlouk (A) for the lower cycle and Damlouk (B) for the upper cycle. The type locality of the Damlouk Member is selected from Wadi Akash for Damlouk (A) (28 m), and Wadi Halgum for Damlouk (B) (52 m) (Jassim *et al.* 1984; Al-Bassam *et al.* 1986; and Karim and Al-Bassam, 1997). The selected studied section is 32 meters thick and includes the complete lower cycle (Damlouk A) in addition to the basinal marly limestone part of the upper cycle (Damlouk B). The sampling of this section is focused on the basinal part of the upper cycle (B1) due to its fresh exposure and relatively thick section. The lower cycle (Damlouk A) is 11 meters thick and includes both shallow marine and deep marine sediments (Jassim *et al.* 1984; Al-Bassam *et al.*, 1986; and Karim and Al-Bassam, 1997**)**. The deep marine unit (A1) is about 9 meters thick and usually consists of phosphatic limestone and chalky limestone (occasionally phosphorite), with occasional silicification (Fig. 3). The phosphatic limestone part of (A1) is becoming marly limestone towards the bottom of the sequence, forming altogether the deep marine part of the cycle. The shallow marine unit of this cycle (A2) consists of 2 meters thick horizon of Nummulitic – shelly limestone. This unit represents part of a shallow marine carbonate bank **(**Karim and Al-Bassam, 1997; Al-Qayim *et al*., 2019**).** This limestone is often hard, protrudes out, and contains abundant and diversified assemblages of *Nummulites.*

The basinal deep marine sediments of the upper cycle (Damlouk B) are the only representative part of the upper cycle (B1), whereby the upper shallow marine part is removed by recent erosion. The exposed and sampled section of this basinal unit (B1) is 21 meters thick, which is considered relatively the thickest in the area. The lower part of this unit is about 10 meters thick buff relatively soft phosphatic limestone. The upper part of this unit is 11 meters thick and consists of white chalky limestone, which displays silicification in the form of dark brown thin cherty layers or nodules (Fig. 3).

MATERIALS AND METHODOLOGY

Field description of the studied section includes lithological documentation and stratigraphic relations. Nine samples are collected from the basinal unit of the upper cycles (Damlouk B). Three samples are from the phosphatic limestone part and six samples are from the silicified chalky limestone part (Fig. 3). The samples are collected in uniform spacing and chosen from hard parts to be suitable for thin sections that are made at the workshop of the Department of Geology, Sulaimani University, and examined under Leitz polarizing microscope for identification of the different species of the planktonic foraminifera. Identification and classification of the examined foraminifera are done following the works of (Pearson and Wade, 2015; Loeblich and Tappan, 1988; Loeblich and Tappan, 2015; and Wade *et al.*, 2011).

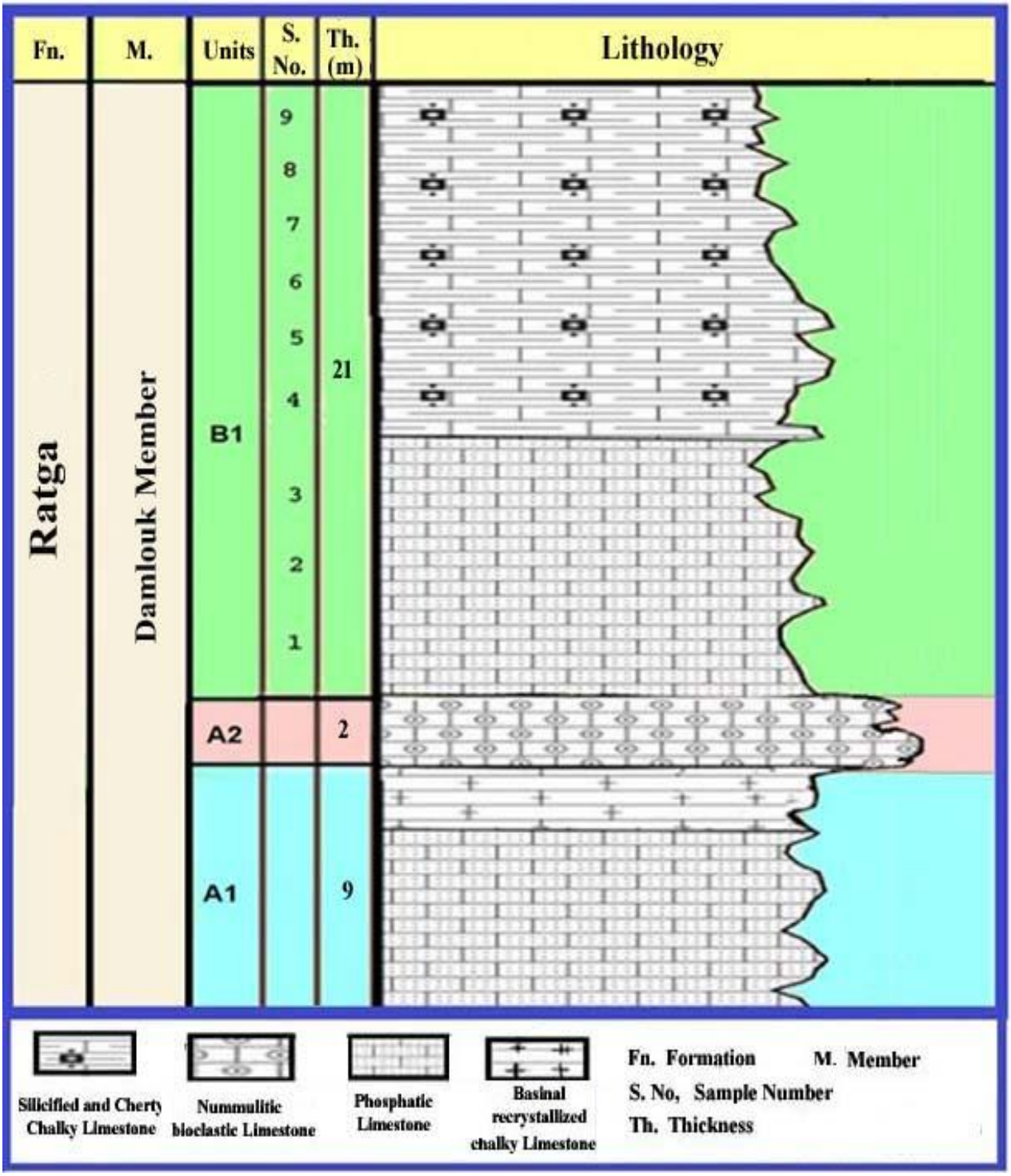

Fig. 3: Lithostratigraphic column of the studied part of the Damlouk Member, Ratga Formation, W. Iraq.

PLANKTIC FORAMINIFERAL ASSEMBLAGES

The first description of Eocene planktic foraminifera was made during the nineteenth Century during early geological exploration in Europe (e.g., Gümbel, 1868; Hantken, 1875; Terquem, 1882). This study is based on an analysis of nine samples taken from the studied section that led to the identification of 30 species belonging to the 11 genera of planktic foraminifera, which are distributed from the lower to the upper part of the section. The planktic foraminifera species recognized within the studied section are: (*Turborotalia cerroazulensis* (Cole); *Turborotalia cocoaensis* (Cushman); *Turborotalia frontosa* Subbotina*; Turborotalia prolata; Turborotalia pseudoampliapertura* Bolli; *Turborotalia* sp.*; Globigerinatheca semiinvoluta* (Keijzer) ; *Globigerinatheca lutherbacheri* Bolli*; Globigerinatheca tropicalis* (Blow and Banner); *Globigerinatheca* sp.*; Acarinina bullbrooki* (Bolli); *Acarinina* sp.; *Catapsydrax dissimilis* (Cushman and Bermúdez), *Catapsydrax* sp.; *Globanomalina* sp.; *Globanomalina planoconica* (Subbotina)*;Hantkenina alabamensis* Cushman; *Hantkenina liebusi* Shokhina*; Hantkenina* sp.; *Chiloguembelina midwayensis* (Cushman)*; Chiloguembelina* sp.1 (Cushman and Renz*; Chiloguembelina cubensis* (Palmer)*; Chiloguembelina* sp.2; *Morozovelloides lehneri* (Cushman and Jarvis); *Morozovelloides coronate* (Blow); *Morozovelloides* sp.*; Subbotina eocaenica* (Gümb)*; Subbotina utilisindex* (Jenkins and Orr) *; Subbotina gortanii* (Borsetti)*; Orbulinoides* sp.)

BIOSTRATIGRAPHY

The studied section of the Ratga Formation yielded rich planktic foraminiferal assemblages of good preservation. Thirty planktic foraminiferal species belonging to eleven genera had been identified (Fig. 4). These planktic foraminiferal assemblages are typical of tropical - subtropical Tethyan character (Berggren and Pearson, 2005). The stratigraphic distribution of the planktic foraminiferal species is shown in Figure (5). The stratigraphic distribution of these planktic foraminifera permits the recognition of three biozones (Fig. 6). These are from the oldest: *Acaranina bullbrooki* Zone, (Middle Lutetian), *Morozovelloides lehneri* Zone, (Late Lutetian) *Globigerinatheka semiinvoluta-Hantkenina alabamensis* Zone (Early Bartonian). These zones are correlated with similar zones which were established by other authors as shown in figures (7and 8). Below is the description of each of these biozones.

1-*Acarinina bullbrooki* –Total Range Zone

Definition: Biostratigraphic interval of this zone characterized by the first Appearance Datum (FAD) and Last Appearance Datum (LAD) of *Acaranina bullbrooki* (Bolli), from the lower to the upper part of the zone.

Thickness: 10 m represented by the samples (1 - 4).

Characteristics: It represents the oldest zone recognized in Ratga Formation. The base of this zone represents unit A2 of the Ratga Formation. Planktic foraminiferal assemblages that dominated throughout the zone are:

Acarinina bullbrooki (Bolli); *Acarinina* sp.; *Chiloguembelina midwayensis* (Cushman)*; Chiloguembelina* sp.1*; Chiloguembelina cubensis* (Palmer)*; Chiloguembelina* sp2*; Turborotalia frontosa* Subbotina*; Subbotina eocaenica* (Guembel)*; Subbotina utilisindex* (Jenkins and Orr) *; Subbotina gortanii* (Borsetti)*; Orbulinoides* sp.*; Turborotalia* sp.

Remarks: This zone was recorded from Late Lutetian (Late Middle Eocene) by (Karim and Kubaysi 2015; Popov *et al.* 2019).

Correlation: This zone is correlatable with the *Globigerinatheka subconglobata* and *Morozovella lehneri* (Part) Zone of (Bolli, 1966; Premoli Silva and Bolli, 1973), with the *Acaranina rotundimarginata -Hantkenina alabamensis* zone of (Krashininikov *et al.*, 1985), *Acaranina bullbrooki* zone of (Popov *et al.*, 2019) (Fig. 7), and correlated with other biostratigraphic subdivisions recognized in Iraq (Fig. 8).

Age: Late Middle Eocene (Middle Lutetian) -P11

2-*Morozovelloides lehneri* Zone Total Range Zone

Definition: Biostratigraphic interval of this zone is characterized by the first Appearance Datum (FAD) and Last Appearance Datum (LAD) of *Morozovelloides lehneri* (Cushman and Jarvis) from the lower to the upper part of the zone.

Thickness: 5 m represented by the samples (4 - 7).

Characteristics: This biozone is recognized at the middle part of the section and characterized by the abundance of planktic foraminifera including *Morozovelloides lehneri* (Cushman and Jarvis). This biozone starts from sample number 4 and ends in sample number 7. It is characterized by 5 m thick of Ratga Formation. The common taxa of this zone are represented by (*Turborotalia cerroazulensis* (Cole); *Turborotalia cocoaensis* (Cushman)*; Turborotalia frontosa* Subbotina*; Turborotalia prolata; Turborotalia* sp.*; Globigerinatheka semiinvoluta* (Keijzer); *Globigerinatheka luterbacheri* Bolli*; Globigerinatheka tropicalis (*Blow and Banner)*; Globigerinatheka* sp.*; Morozovelloides lehneri* (Cushman and Jarvis); *Morozovelloides coronate* (Blow); *Morozovelloides* sp.*; Subbotina eocaenica* (Gümb)*; Subbotina utilisindex* (Jenkins and Orr); *Subbotina gortanii* (Jenkins and Orr); *Orbulinoides* sp.

Remarks: This zone was recorded from Middle Lutetian by (Bolli, 1963; Premoli silva and Bolli, 1973; and Bergreen and Pearson, 2015).

Correlation: This zone is correlatable with the *Globorotalia lehneri (part)- Orbulinoides bekhmanni* zone of Blow 1979, and to the *Globigerinatheka ltukemenica* zone of Krashininikov *et al.* 1985, *Hantkenina alabamensis* zone of Popov *et al.* 2019 (Fig. 7) and correlated with biostratigraphic subdivisions recognized in Iraq (Fig. 8).

Age: Late Middle Eocene (Late Lutetian)-P 12, P13

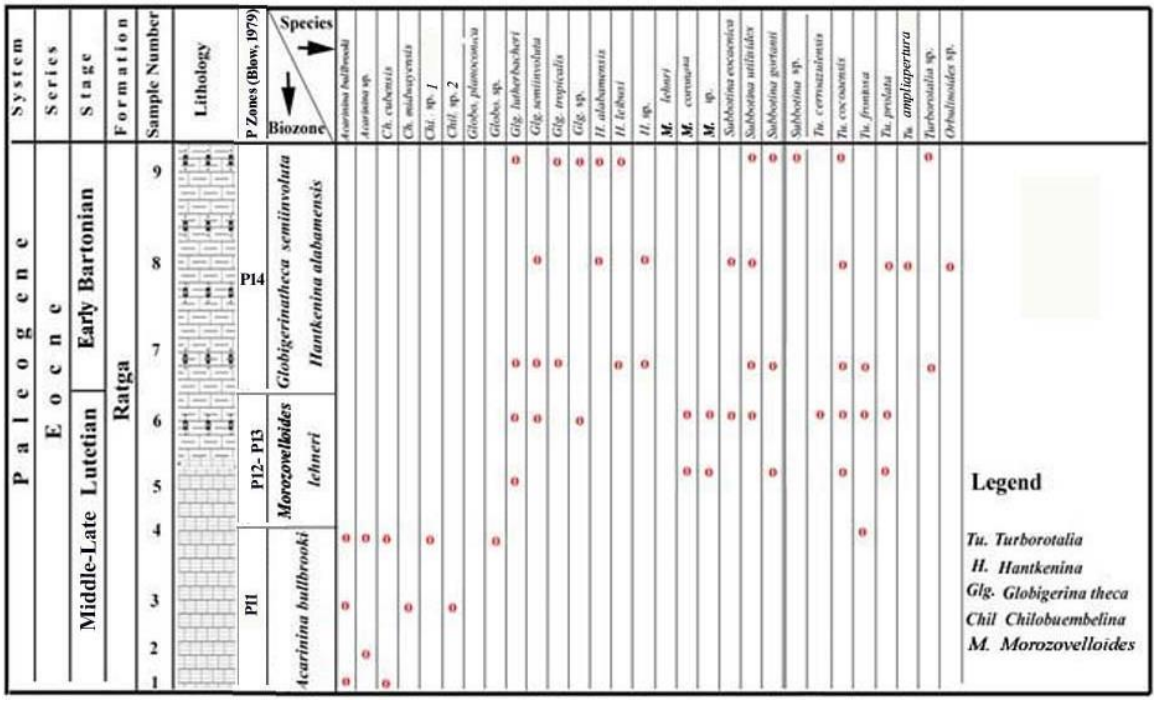

Fig. 4: Biostratigraphic chart of the studied section of the Ratga Formation, Western Desert, Iraq.

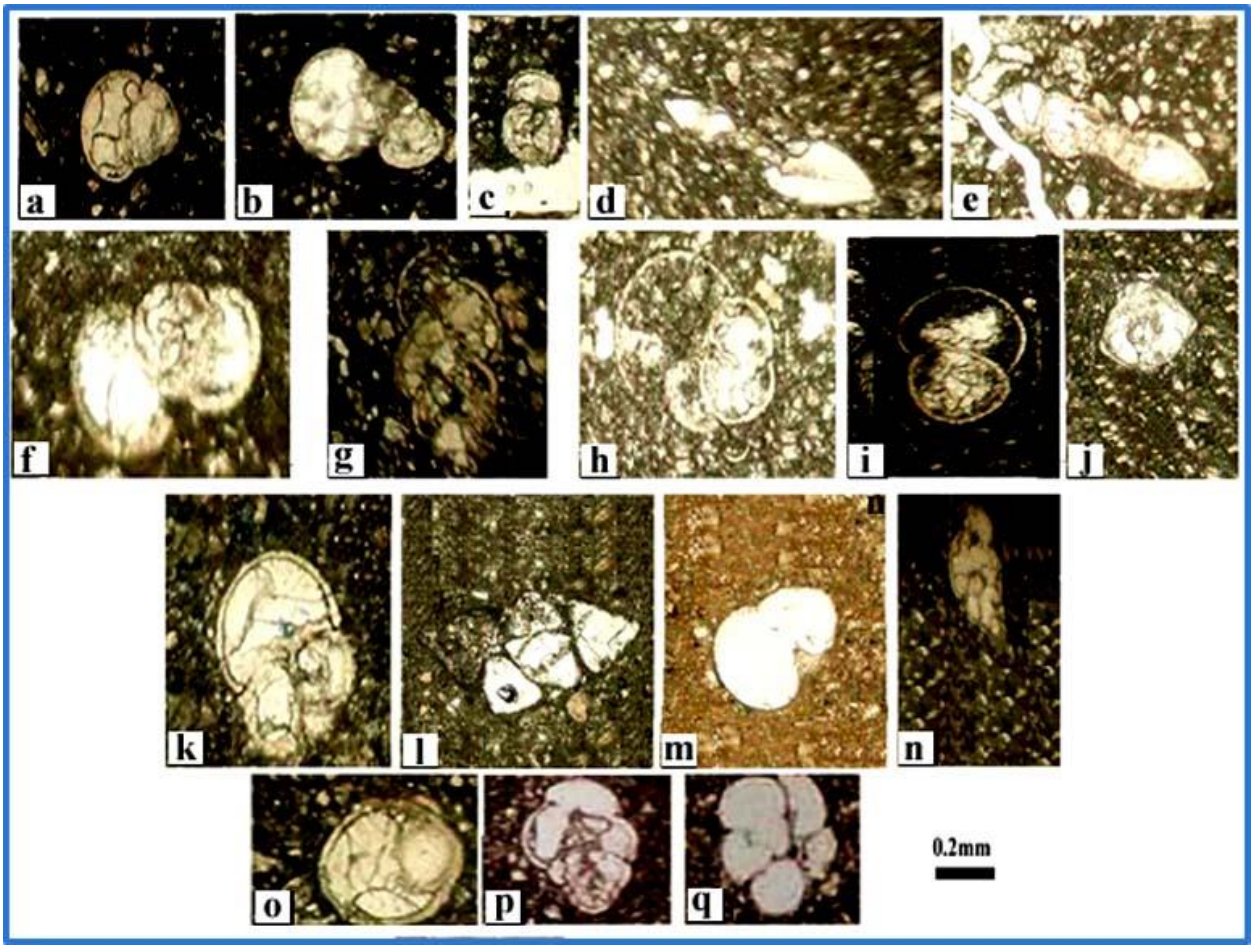

Fig. 5: **a**. *Turborotalia frontosa* Subbotina 1953, sample no. 4)*;* **b.** *Globigerinatheka semiinvoluta* (Keijzer 1945), sample no. 8); **c.** *Acarinina bullbrooki* (Bolli, 1957) sample no. 4*;* **d.** *Globanomalina* sp. sample no. 4*;* **e.** *Hantkenina alabamensis* (Cushman, 1924) (Sample No. 9)*;* **f.** *Subbotina eocaena* (Gümbel, 1868), sample no. 8; **g.** *Chiloguembelina* sp.2, sample no. 4*;* **h.** *Turborotalia frontosa* Subbotina 1953, sample no.. 6*;* **i.** *Globigerinatheka tropicalis* (Blow and Banner, 1962), sample no. 9; **j.** *Morozovelloides lehneri* (Cushman and Jarvis 1929), sample no..5); **k.** *Subbotina utilisindex* (Jenkins and Orr 1973), sample no. 9); **l**. *Morozovelloides* sp., sample no. 5; **m.** *Morozovelloides* sp., sample no. 5); **n.** *Chilogumbelina cubensis*, (Palmer 1934), sample no. 4); **o.** *Orbulinoides* sp., sample no.8; **p.** *Chiloguembelina* sp.1; sample no. 3*;* **q.** *Subbotina* sp., sample no. 9.

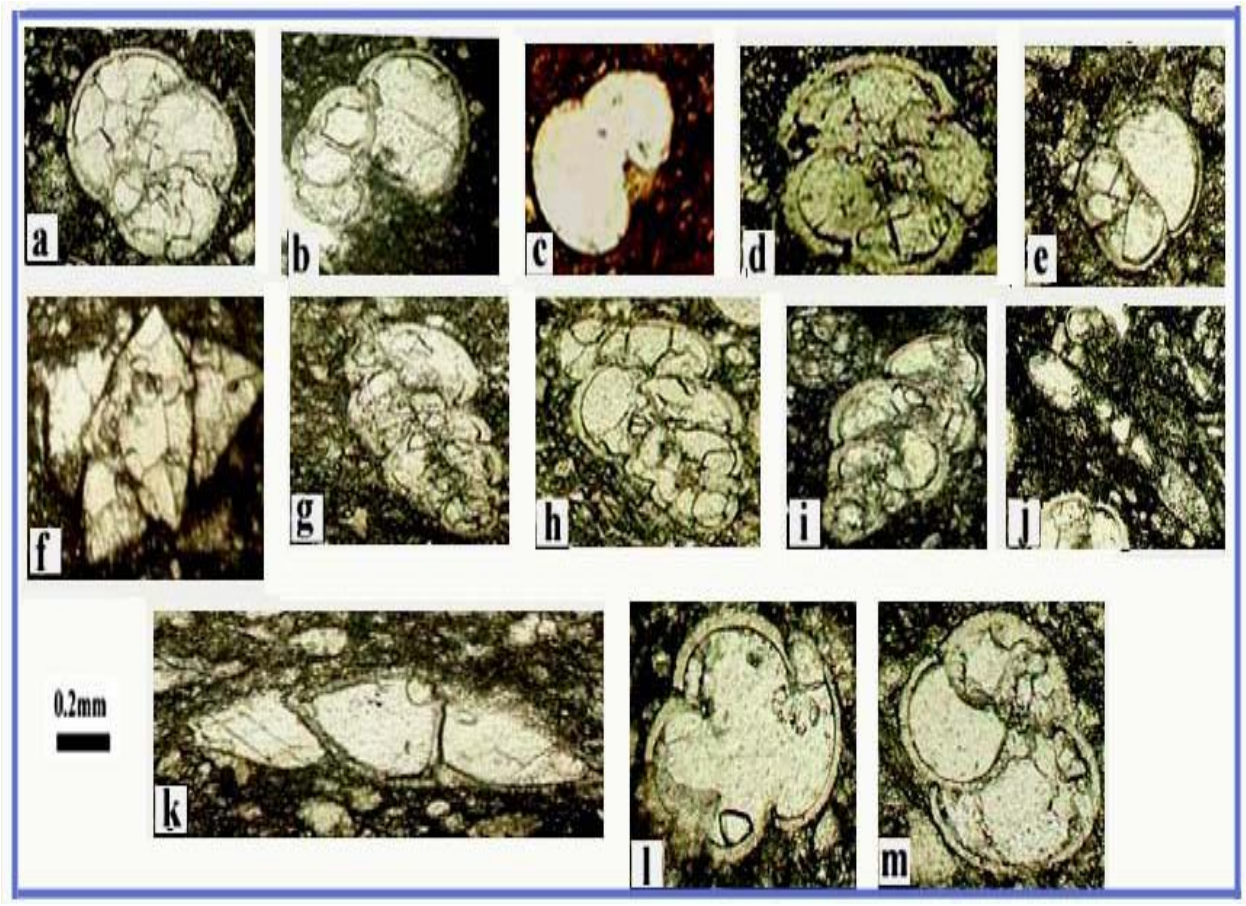

Fig. 6: **a**. *Turborotalia cocoaensis* (Cushman, 1928), sample no. 9; **b**. *Turborotalia cerroazulensis* (Cole, 1928), sample no. 6; **c**. *Turborotalia prolata* Blow, 1979, sample no. 8*;* **d.** *Globigerinatheka luterbacheri* Bolli, 1972, sample no. 9*;* **e**. *Subbotina gortanii* (Borsetti, 1959), sample no. 5; **f.** *Hantkenina liebusi* Shokhina, 1937, Sample no. 9; ***g***- *Chiloguembelina midwayensis* (Cushman, 1940), sample no. 3; **h**. *Chiloguembelina trinitatensis* (Cushman and Renz, 1942), sample no. 4; **i**- *Chiloguembelina* sp.1, sample no.4; **j.** *Hantkenina liebusi* (Shokhina, 1937), sample nol.3; **k.** *Acarinina bullbrooki* (Bolli, 1957) sample no. 4; **l.** *Globanomalina planoconica* (Subbotina, 1953), sample nol.3; **m.** *Globigerinatheka semiinvoluta* (Keijzer, 1945), sample no 6.

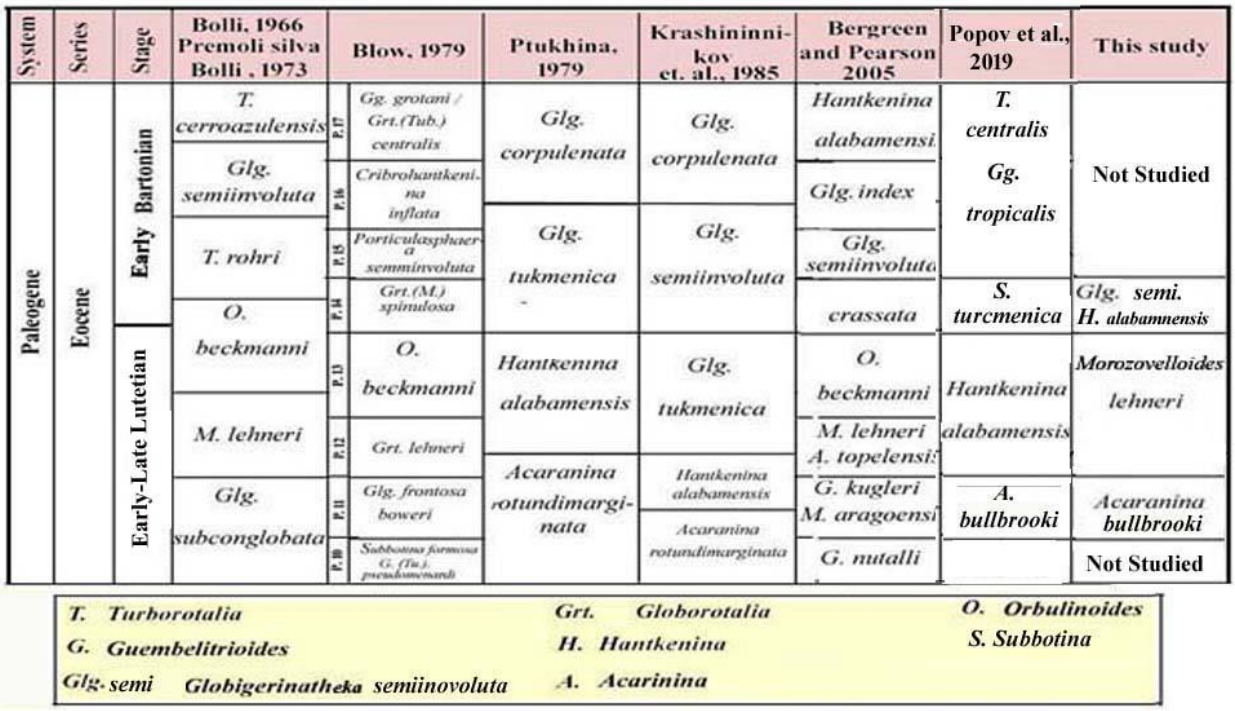

Fig. 7: Correlation of the zonal scheme of part of the Ratga Formation, with other biostratigraphic zones, established outside Iraq.

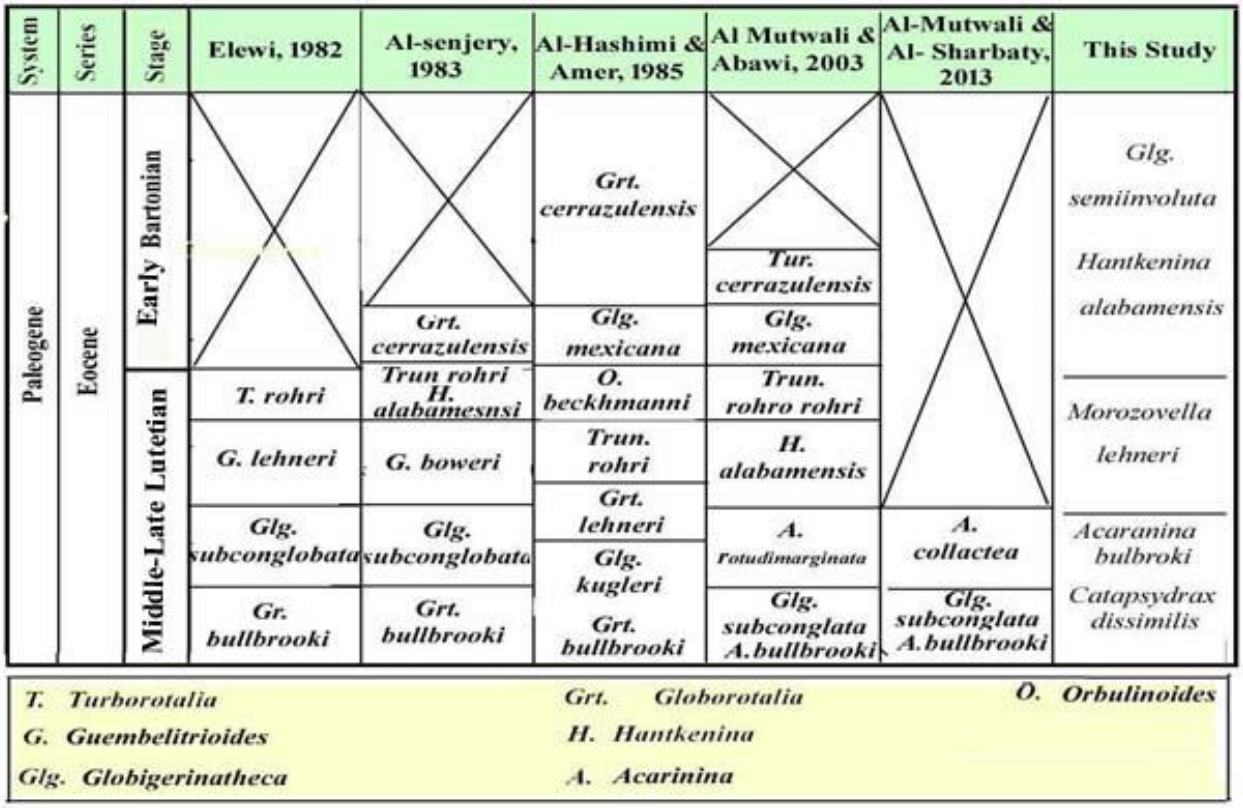

Fig. 8: Correlation of the zonal scheme of part of the Ratga Formation, with other biostratigraphic zones, established inside Iraq.

3-*Globigerinatheka semiinvoluta*; -*Hantkenina alabamensis* Assemblages Zone

Definition: Biostratigraphic interval of this zone characterized by the assemblage of the nominate taxa *Globigerinatheka semiinvoluta* (Keijzer) -*Hantkenina alabamensis* Cushman.

Thickness: 6m represented by the samples (7 - 9).

Characteristics: It represents the zone recognized at the upper part of the studied section. Planktonic foraminiferal assemblages that dominated throughout the zone are:

(*Turborotalia cerroazulensis* (Cole); *Turborotalia cocoaensis* (Cushman); *Turborotalia frontosa* Subbotina*; Turborotalia prolata; Turborotalia ampliapertura; Turborotalia* sp.*; Globigerinatheka semiinvoluta* (Keijzer); *Globigerinatheka luterbacheri* Bolli*; Globigerinatheka tropicalis; Globigerinatheka* sp.*; Globanomalina* sp.; *Globanomalina planoconica* (Subbotina)*; Hantkenina alabamensis* Cushman; *Hantkenina liebusi* Shokhina*; Hantkenina* sp.; *Chiloguembelina midwayensis* (Cushman)*; Chiloguembelina trinitatensis* (Cushman and Renz)*; Chiloguembelina cubensis* (Palmer)*; Chiloguembelina* sp.*; Subbotina eocaenica* (Gümb)*; Subbotina utilisindex* (Jenkins and Orr)*; Subbotina gortanii* (Jenkins and Orr).

Remarks: This zone was recorded from the early most Bartonian zone p.19 (Early Late Eocene) by (Premoli Silva *et. al.*, 2002; Karim and Kubaysi, 2015; Bolii, 1966; Bergreen and Pearson, 2015; Krashininikov et.al., 1985).

Correlation: This zone is correlatable with the *Globigerinatheka semiinvoluta-Hantkenina alabamensi Globigerinatheka index* zone of (Bergreen and Pearson, 2015), (Fig. 7), *Subbotina turcmenica* zone of (Popov, *et al.*, 2019) and correlated with other subdivisions in Iraq (Fig. 8).

Age: Early Late Eocene (Early Bartonian) - P14

CONCLUSIONS

This study has the following conclusions:

1-The basinal part of the upper cycle of the Damlouk Member of Ratga Formation in the studied section is characterized by abundant planktonic foraminiferal assemblages.

2. Based on the proposed stratigraphic range of the identified planktonic foraminifera, the section is subdivided into three biozones *Acarinina bullbrooki* Zone, (Middle Lutetian), *Morozovelloides lehneri* Zone, (Late Lutetian), and *Globigerinatheka similiuluta - Hantkenina alabamensis* Zone,(Early Bartonian).

3. This basinal part of the upper cycle (Damluk B) of the Damlouk Member of the Ratga Formation extends in age from the Middle-Late Lutetian to Bartonian.

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