

Biostratigraphy of Planktonic Foraminifera of Jaddala Formation (Eocene), Bara area, Northwestern Iraq

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ABSTRACT

A surface section of Jaddala Formation was studied near Bara Village in the western plunge area of Sinjar anticline northwestern Iraq . The sequences consist of marl, marly limestone and limestone beds. Detailed study of planktonic foraminifera revealed (38) species belonging to (14) genera; the stratigraphic distribution of these species permits the recognition of five zones; these are: *Morozovella aragonensis* Zone, *Acarinina pentacamerata* Zone, *Acarinina bullbrooki* Zone, *Globigerinatheka subconglobata* Zone and *Acarinina collactea* Zone. These zones indicate that Jaddala Formation is of Early - Middle Eocene age.

Keywords: Biostratigraphy, Eocene, Foraminifera Planktonic, Bara area, Iraq.

الطباقية الحياتية للفورامينيفرا الطافية في تكوين جدالة (الايوسين)، في منطقة بارة،
شمال غرب العراق

إيناس سامي الشربتي

ماجد مجدي المتولي

قسم علوم الأرض

كلية العلوم

جامعة الموصل

الملخص

يتناول البحث الحالي دراسة الطباقية الصخرية والحياتية لتكوين جدالة المنكشف على السطح قرب قرية بارة في منطقة الغاطس الغربي لطفية سنجار المحدبة. تتألف تتابعات المقطع قيد الدرس من صخور المارل والحجر الجيري المارلي والحجر الجيري، وتتميز هذه التتابعات بوفرة حشود الفورامينيفرا الطافية حيث

تم تشخيص (٣٨) نوعاً التي تعود إلى (١٤) جنساً، واعتماداً على هذه الحشود من الفورامينيفرا الطافية قسمت تتابعات المقطع قيد البحث الى خمسة انطقه حياتية وهي من الاقدم في الاسفل إلى الأحدث في الأعلى:

5- *Acarinina collactea* Zone (P12) (part).

4- *Globigerinatheka subconglobata* Zone (P11).

3- *Acarinina bullbrooki* Zone (P10).

2- *Acarinina pentacamerata* Zone (P9).

1- *Morzovella aragonensis* Zone (P8) (part)

دللت هذه الانطقة الحياتية ان عمر تكوين جدالة في المقطع قيد الدرس هو الايوسين المبكر - الاوسط.

الكلمات الدالة: الفورامينيفرا الطافية، الطباقية الحياتية، الايوسين، منطقة بارة، العراق.

INTRODUCTION

The first description of Jaddala Formation was given by Henson in (1940) (Bellen *et al.*, 1959), it's type section lies near Jaddala village on the southern limb of Sinjar anticline, fifteen kilometers to the west of Sinjar city, northwest Iraq. According to Bellen *et al.*, (op. cit) the Jaddala Formation consists of marl, marly limestone and chalky limestone. it has a wide distribution during Eocene age in Iraq, extending into the mesopotamian zone, foothill zone and into the northern and western parts of the stable shelf area (Jassim *et al.*, 1984). Previous stratigraphic and paleontologic studies indicate that Jaddala Formation was deposited in deep open marine basin during late early - late Eocene age (Buday, 1980; Al-Hashimi and Amer, 1985; Ismail, 1989 and Al-Muwali, 1992), while its age restricted to late early - middle Eocene in Sinjar area (Elewi, 1982; Al-Mutwali and Al-Banna, 2002; Ismail, 2006 and Al-Sharbaty, 2011).

MATERIALS AND LITHOLOGY

The present study based on 74 samples which were collected from the surface section of 583 m thick of Jaddala Formation that exposed near Bara Village in the western plunge area of Sinjar anticline extending between the locations (36° 20' 25"N , 41° 28' 03" E) and (36° 21' 07" N , 41° 27' 25" E) (Fig. 1). The field work showed that Jaddala Formation consists of marl and marly limestone beds of pale yellow to pale grey in colour, with hard limestone beds of brownish colour occurs at the lower and upper parts of the section (Fig. 2). The lower boundary of Jaddala Formation is unconformable, sharp and clear with the

underlining Sinjar Formation (Paleocene - early Eocene) (Maala, 1977 and Al-Haj, 2001) (Fig. 3). The upper boundary is unconformable with the Palani Formation (Oligocene), where it is marked by a conglomerate bed (1m thick) rich with chert pebbles, iron oxides and glauconite grains exist at the base of Palani Formation (Fig. 4) .

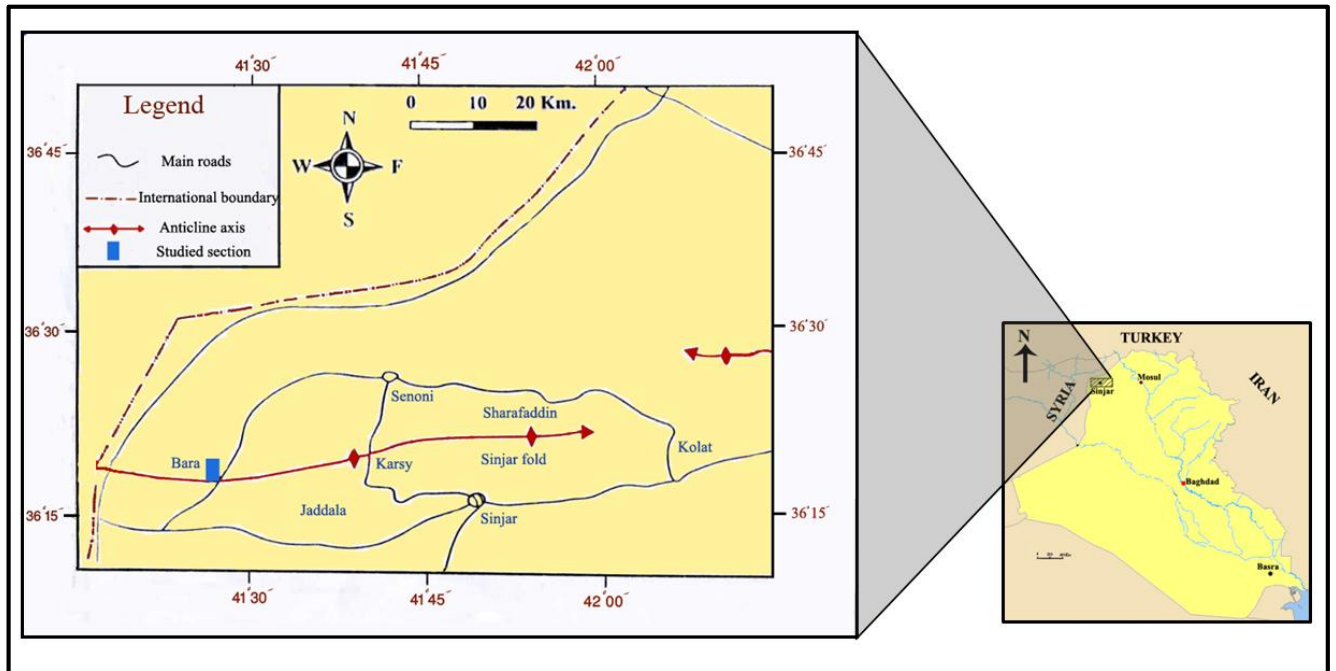


Fig 1: Location Map.



Fig. 2: Image Showing Sequences of Marl and Marly Lime stone in the Lower Part of Jaddala Formation.



Fig. 3: Image Showing the Lower Boundary of Jaddala Formation with Sinjar Formation.

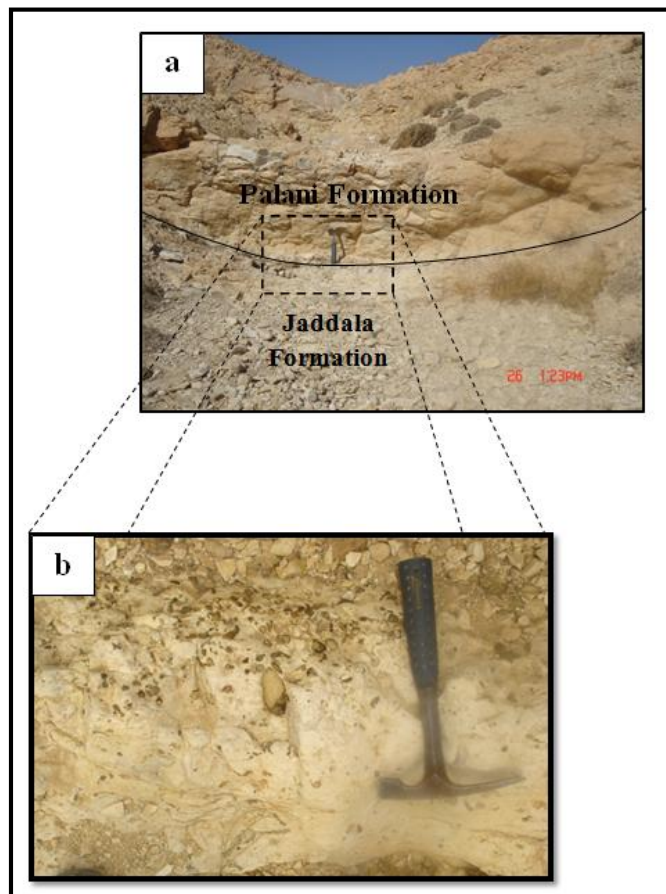


Fig. 4: Image Showing the Upper Boundary of Jaddala Formation with Palani Formation.

BIOSTRATIGRAPHY

The studied section of Jaddala Formation yielded rich planktonic foraminiferal assemblages of good preservation. Thirty-eight planktonic foraminiferal species belonging to fourteen genera have been identified (Fig. 5). These planktonic foraminiferal assemblages are typical of tropical - subtropical Tethyan character. The stratigraphic distribution of the planktonic foraminiferal species is shown in (Fig. 6). The stratigraphic distribution of these planktonic foraminifera permits the recognition of five biozones (Fig. 7), these are from older at base:

5-*Acarinina collactea* Zone (P12) (part).

4-*Globigerinatheka subconglobata* Zone (P11).

3-*Acarinina bullbrooki* Zone (P10).

2-*Acarinina pentacamerata* Zone (P9).

1- *Morzovella aragonensis* Zone (P8) (part).

These zones were correlated with similar zones which were established by other authors as shown in (Figs. 8, 9). The Paleogene planktonic foraminifera zonal scheme (P) which is followed is that of Berggren *et al.*, (1995).

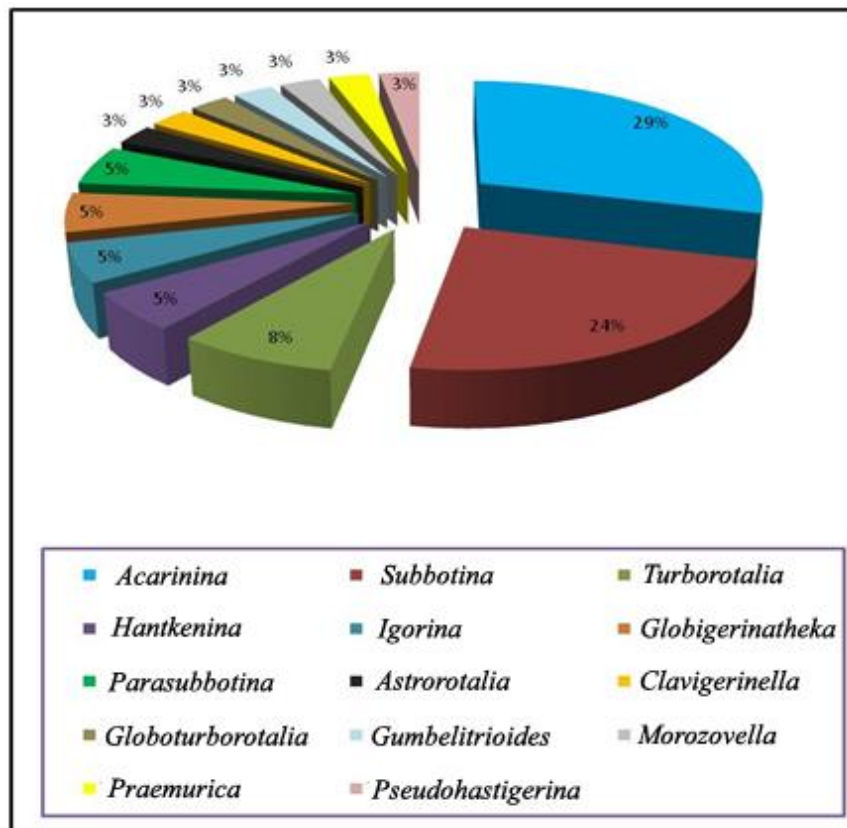


Fig. 5: Percentages of Planktonic Foraminifera in Jaddala Formation.

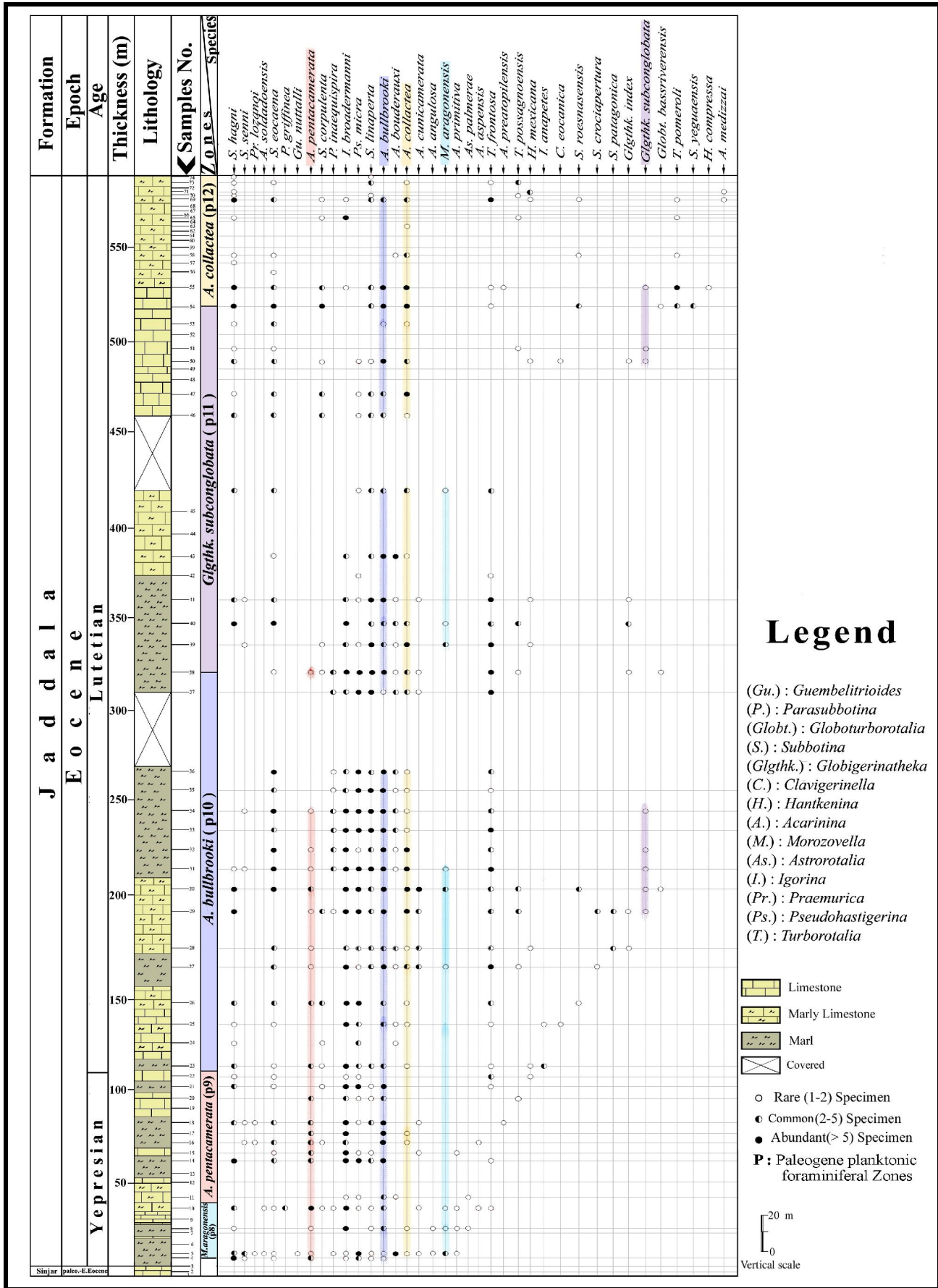


Fig . 6: The Stratigraphic Distribution of Planktonic Foraminifera in Jaddala Formation, Sinjar Area, Northwestern Iraq.

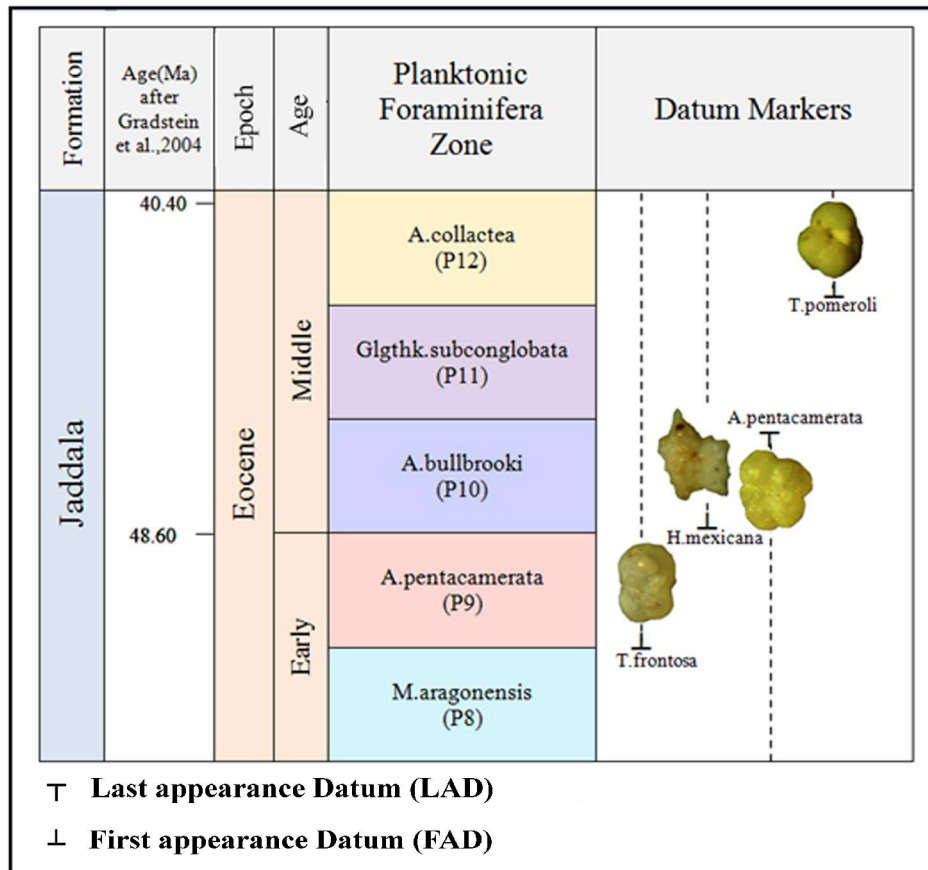


Fig. 7: Datum Plane of Planktonic Foraminiferal Zonation Identified in the Studied Area.

1- *Morozovella aragonensis* Partial - Range Zone (P8) (Part)

Defination: Partial range of nominate taxon between the first appearance of *Acarinina pentacamerata* (Subbotina) at the base (which is not included in this study) and the first appearance of *Turborotalia frontosa* (Subbotina) at the top.

Age: Early Eocene.

Thicknees: 33m represented by the samples (4 - 10).

Characteristics: It represents the oldest zone that recognized in Jaddala Formation. The base of this zone represents the lower unconformable contact of Jaddala Formation with the underlying Sinjar Formation. Planktonic foraminiferal assemblages that dominated throughout the zone are: *Morozovella aragonensis* (Nuttalli), *Acarinina bullbrooki* (Bolli), *Acarinina pentacamerata* (Subbotina), *Igorina broadermanni* (Cushman and Bermudez), *Subbotina hagni* (Gohrbandt), *Subbotina senni* (Beckmann), *Parasubbotina inaequispira* (Subbotina), *Pseudohastigerina micra*(Cole), *Subbotina linaperta*(Finlay), *Acarinina collactea* (Finlay), *Acarinina cunicamerata*(Blow), *Acarinina angulosa*(Bolli).

Correlation: This zone correlatable with the *Morozovella aragonensis* Zone of Bolli (1966), Toumarkine and Luterbacher (1985) and Berggren *et al.*, (1995), it is also equivalent to the *Globorotalia aragonensis* Zone of Berggren (1969), Stainforth *et al.*, (1975), Elewi (1982).These zones are assigned to the Early Eocene.

Formation	Epoch	Age	Bolli (1966) Premoli silva Bolli (1973) Caribbean & Trinidad	Berggren, 1969 General	Postuma, 1971 General	Stamforth et al., 1975 General	Krascheninikov, 1965 General Bolli & Krascheninikov, 1977 Syria	Blow, 1979 General	Tourmarkine & Luterbacher, 1985 General	Berggren et al., 1995	Berggren & Pearson, 2005	Present Study			
Jaddala Formation	Eocene	Late	Tu. cerroazulensis	Gg. grotaani Gr. centralis Cribroauctum inflata	Grt. cerroazulensis	Grt. cerroazulensis	Grt. cumatensis	G. g. grotaani / Grt (Tub) centralis	Turb. cerroazulensis	T. cerroazulensis	H. alabamensis				
			Gl. seminivoluta	Gl. mexicana	Glgs. mexicana	Glghk. Seminivoluta	Glgs. cocoensis	Porticulasphaera seminivoluta	Grt. cerroazulensis	Po. seminivoluta	T. cunialensis Criniflata	G. index			
			T. rohri	T. rohri gfhk. boweri	Trunc. rohri	Trunc. rohri	Trunc. rohri	Grt. (M.) s. spinulosa	Grt. (M.) s. spinulosa	T. rohri	T. rohri M. spinulosa	O. beckmanni	M. crassata		
			O. beckmanni	O. beckmanni	O. beckmanni	O. beckmanni	H. alabamensis	O. beckmanni	O. beckmanni	O. beckmanni	O. beckmanni	Gb. beckmanni	O. beckmanni		
			M. lehnerei	Gr. lehnerei	Gr. lehnerei	A. roundimarginata	Gr. lehnerei	Gr. lehnerei	Gr. lehnerei	Gr. lehnerei	M. lehnerei	M. lehnerei	M. lehnerei A. topilensis	A. collecta	
			Glghk. s. subconglobata	Gl. kugleri	Glgs. kugleri	Glgs. kugleri	Glghk. subconglobata	G. kugleri S. frontosa boweri	G. kugleri S. frontosa boweri	G. kugleri S. frontosa boweri	Glghk. subconglobata	Gb. kugleri M. aragonensis	G. kugleri M. aragonensis	G. kugleri M. aragonensis	Glghk. subconglobata
		Early	Middle	H. nuttalli	H. aragonensis	Gr. bullbrookii	H. aragonensis	H. aragonensis	subbotina f. formosa / G. (Tub) pseudomayeri	H. nuttalli	H. nuttalli	H. nuttalli	G. nuttalli	A. bullbrookii	
				A. pentacamerata	A. densa	Gr. formosa - aragonensis	Gr. pentacamerata	A. pentacamerata	Gr. (A) aspensis / G. lozanoi prolata	Gr. (A) aspensis / G. lozanoi prolata	A. pentacamerata	P. palmerae H. nuttalli	A. cunicamerata	A. pentacamerata	
				M. aragonensis	Gr. aragonensis	Gr. aragonensis	Gr. aragonensis	Gr. aragonensis	Gr. (M) aragonensis Grt. (M) formosa	Gr. (M) aragonensis Grt. (M) formosa	M. aragonensis	M. aragonensis	M. aragonensis	A. pentacamerata	M. aragonensis
				M. f. formosa	Gr. formosa	Gr. f. formosa	Gr. marginodentata	Gr. marginodentata	Gr. (M) formosa Grt. (M) lensiformis	Gr. (M) formosa Grt. (M) lensiformis	M. f. formosa	M. f. formosa	M. aragonensis M. formosa	M. aragonensis M. subbotina	M. aragonensis M. subbotina
				M. subbotina	Cr. subbotina P. wilcoxensis	Gr. rex	Gr. subbotina	Gr. subbotina	Gr. (A) wilcoxensis berggreni	Gr. (A) wilcoxensis berggreni	M. subbotina	M. subbotina	M. formosa / M. Lensisiformis M. aragonensis	M. formosa	M. formosa
				M. edgari			Gr. subbotina	Gr. subbotina	M. edgari	M. edgari	M. edgari	M. edgari	M. velascensis M. formosa / M. Lensisiformis	M. marginodentata	M. marginodentata

Fig. 8: Correlation of the Zonal Scheme of the Jaddala Formation, Sinjar Area, with other Biostratigraphic Zones Established Outside Iraq.

2 - *Acarinina pentacamerata* Partial - Range Zone (P9).

Definition: Partial range of nominate taxon between the first appearance of *Turborotalia frontosa* (Subbotina) at the base and the initial appearance of *Hantkenina mexicana* Cushman at the top.

Age: Late Early Eocene .

Thickness: 70m represented by the samples (11 - 22).

Characteristics: The nominate taxon dominates the assemblages of this zone, besides the reliable abundance of *Acarinina bullbrooki* (Bolli) and *Igorina broadermanni*, with the continuous appearance of these planktonic foraminiferal species from the previous zone: *Subbotina linaperta*(Finlay), *Acarinina aspensis* (Colom), *Subbotina eoceana*(Guembel), *Turborotalia frontosa* (Subbotina), *Subbotina senni* (Beckmann), *Pseudohastigerina micra*(Cole), *Subbotina hagni* (Gohrbandt), *Morozovella aragonensis*(Nuttall), *Acarinina primitiva*(Finlay), *Acarinina collactea* (Finlay), *Acarinina cunicamerata*(Blow).

Correlation: The present zone is equivalent to the same zone of Bolli (1966), Bolli and Krasheninnikov (1977) and Toumarkine and Luterbacher (1985), it is correlated to the *Globorotalia pentacamerata* of Elewi (1982), it is also equivalent to *Acarinina pentacamerata* Zone recorded in Iraq by Al-Mutwali (1992) and Al-Mutwali and Abawi (2003) . All these zones are assigned to the uppermost Early Eocene.

3 - *Acarinina bullbrooki* Partial - Range Zone (P10).

Definition: Partial range of nominate taxon between the first appearance of *Hantkenina mexicana* Cushman at the base and the last appearance of *Acarinina pentacamerata* (Subbotina) at the top.

Age: Early Middle Eocene .

Thickness: 210m represented by the samples (23 - 38).

Characteristics: The base of this biozone is marked by the initial appearance of the representatives of the genus *Hantkenina* (*Hantkenina mexicana* Cushman). The first forms belonging to the genus *Globigerinatheka* are rarely appear in this biozone which represented by the species *Globigerinatheka subconglobata* (Shutskaya) and *Globigerinatheka index* (Finlay). The recorded planktonic foraminiferal assemblages in this biozone are represented by well diversified forms of *Acarinina bullbrooki* (Bolli), *Acarinina boudreauxi* Fleisher, *Acarinina collactea* (Finlay), *Igorina broadermanni* (Cushman and Bermudez), *Turborotalia frontosa* (Subbotina), *Subbotina eoceana* (Guembel), *Subbotina linaperta*(Finlay), *Parasubbotina inaequispira* (Subbotina) and *Pseudohastigerina micra* (Cole).

Correlation: Based on the faunal similarities this zone is correlatable with the *Hantkenina nuttalli* Zone of Bolli (1966), Toumarkine and Luterbacher (1985), Berggren *et al.* (1995) and Berggren and Pearson (2005), it is also equivalent to the *Hantkenina aragonensis* Zone of Berggren (1966). Stainforth *et al.*, (1975) and Bolli and Krasheninnikov (1977). It is correlated with the *Globorotalia bullbrooki* Zone of Postuma, (1971). Elewi, (1982) and Al-Hashimi and Amer, (1985). Also equivalent to the *Subbotina formosa formosa* / *Globorotalia* (*Turborotalia*)

pseudomayeri Zone of Blow (1979), *Acarinina bullbrooki* Zone of Al-Mutwali (1992) and Al-Mutwali and Abawi (2003). All these Zones are assigned to the early Middle Eocene age.

4- *Globigerinatheka subconglobata* Partial - Range Zone (P11).

Definition: Partial range of nominate taxon between the last occurrence of *Acarinina pentacamerata* (Subbotina) at the base and the first appearance of *Turborotalia pomeroli* (Toumarkine and Bolli) at the top.

Age: Middle Eocene .

Thickness: 200m represented by the samples (39 - 54).

Characteristics: The recorded planktonic foraminiferal assemblages in this biozone are abundant in its lower part while they are rare in middle and upper parts of this biozone, they are represented by: *Acarinina bullbrooki* (Bolli), *Acarinina cunicamerata* (Blow), *Acarinina collactea* (Finlay), *Acarinina boudreauxi* Fleisher, *Igorina broadermanni*(Cushman and Bermudez), *Subbotina linaperta* (Finlay), *Subbotina eocaena* (Guembel), *Subbotina senni* (Beckmann), *Subbotina hagni* (Gorbandt), *Subbotina corpulenta*(Subbotina), *Morozovella aragonensis* (Nuttall), *Globigerinatheka subconglobata* Cushman, *Globigerinatheka index* (Finlay), *Hantkenina mexicana* Cushman, *Clavigerinella eocanica* (Nuttall).

Correlation: Based on similarities of planktonic foraminiferal occurrence the present zone is equivalent to the same zone of Bolli (1966), Stainforth *et al.* (1975), Toumarkine and Luterbacher (1985), Elewi (1982) and Al- Mutwali (1992), it is also equivalent to the *Globigerapsis kugleri/ M. aragonensis* Zone (p11) of Berggren *et al.*, (1995); Berggren and Pearson (2005). All these zones are assigned to the Middle Eocene age.

5 - *Acarinina collactea* Partial - Range Zone (P12) (Part).

Definintion: Partial range of nominate taxon between the first appearance of *Turborotalia pomeroli* (Toumarkine and Bolli) which marked the lower boundary of this biozone to the top of the studied section of Jaddala Formation.

Thickness: 70 m represent by the samples (55 - 74).

Characteristictics: This zone represents the upper part of the studied section . The recorded planktonic foraminifera in this zone are: *Turborotalia pomeroli* (Toumarkine and Bolli), *Turborotalia possagnoensis* (Toumarkin and Bolli), *Turborotalia frontosa* (Subbotina), *Subbotina linaperta* (Finlay), *Subbotina eocaena* (Guembel), *Subbotina hagni* (Gorbandt), *Subbotina corpulenta* (Subbotina), *Subbotina rosnaesensis* Olsson and Berggren, *Acarinina collactea* (Finlay), *Acarinina boudreauxi* Fleisher, *Acarinina bullbrooki* (Bolli), *Globigerinatheka subconglobata* (Shutskaya), *Igorina broadermanni* (Cushman and Bermudez), *Globoturborotalia bassriverensis* Olsson and Hemleben, *Hantkenina medizzai* (Toumarkine and Bolli).

Correlation: This zone is equivalent to the *Morozovella lehneri* Zone (p12) of Bolli (1966), Toumarkine and Luterbacher, (1985) and Berggren *et al.*, (1995). It is

also equivalent to *Acarinina rotundimarginata* Zone of Bolli and Krasheninnikov, (1977) and Al-Mutwali, (1992). These zones are assigned to the Middle Eocene age.

CONCLUSIONS

On the basis of geological ranges of planktonic foraminiferal species, the studied surface section of Jaddala Formation in Bara area has been precisely divided into five biostratigraphic zones: *Morzovella aragonensis* (P8), *Acarinina pentacamerata* (P9), *Acarinina bullbrooki* (P10), *Globigerinatheka subconglobata* (P11) and *Acarinina collactea* (P12) Zones. These zones clearly indicate that the Jaddala Formation is of Early - Middle Eocene age.

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PLATE 1

Fig. 1a : *Morozovella aragonensis* (Nuttall). Umbilical side. Sample, No. 8.

Fig. 1b: *Morozovella aragonensis* (Nuttall). Spiral side. Sample, No. 30.

Fig. 1c : *Morozovella aragonensis* (Nuttall). Edge side. Sample, No. 30.

Fig. 2a : *Acarinina pentacamerata* (Subbotina). Umbilical side. Sample, No. 10.

Fig. 2b : *Acarinina pentacamerata* (Subbotina). Spiral side. Sample, No.10.

Fig. 2c : *Acarinina pentacamerata* (Subbotina). Edge side. Sample, No.10.

Fig. 3a : *Acarinina bullbrooki* (Bolli). Umbilical side. Sample, No.14.

Fig. 3b : *Acarinina bullbrooki* (Bolli). Spiral side. Sample, No.14.

Fig. 3c : *Acarinina bullbrooki* (Bolli). Edge side. Sample, No.14.

Fig. 4a : *Globigerinatheka subconglobata* (Shutskaya). Umbilical side.
Sample, No. 34.

Fig. 4b : *Globigerinatheka subconglobata* (Shutskaya). Spiral side. Sample,
No. 34.

Fig. 4c : *Globigerinatheka subconglobata* (Shutskaya). Edge side. Sample, No. 34.

Fig. 5a : *Acarinina collactea* (Finlay). Umbilical side. Sample, No. 54.

Fig. 5b : *Acarinina collactea* (Finlay). Spiral side. Sample, No. 34.

Fig. 5c : *Acarinina collactea* (Finlay). Edge side. Sample, No. 29.

PLATE 1

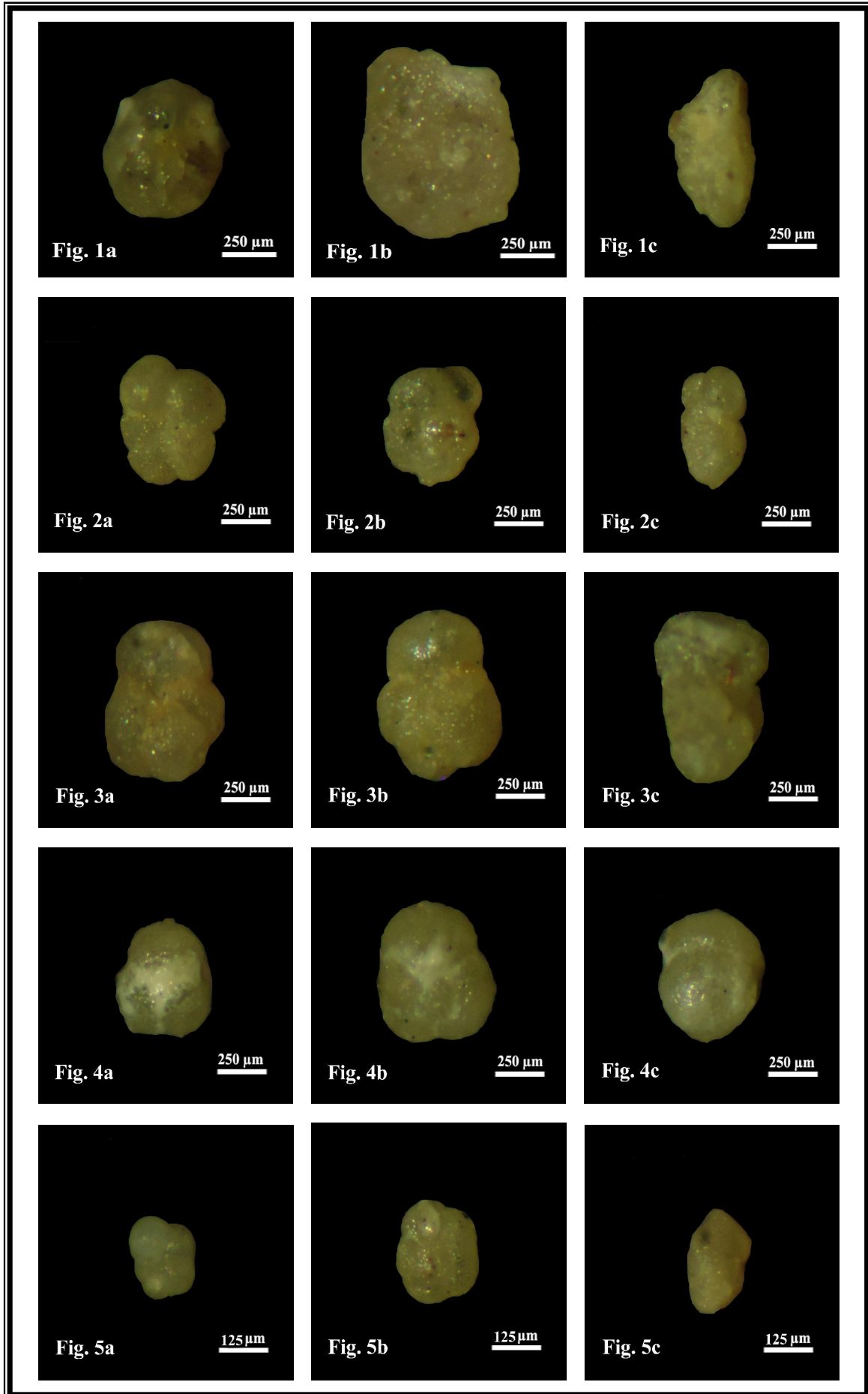


PLATE 2

Fig. 1a : *Parasubbotina inaequispira* (Subbotina) . Umbilical side. Sample, No. 3.

Fig. 1b : *Parasubbotina inaequispira* (Subbotina) . Spiral side. Sample, No. 32 .

Fig. 1c : *Parasubbotina inaequispira* (Subbotina) . Edge side. Sample, No. 32.

Fig. 2a : *Subbotina crociapertura* Blow. Umbilical side. Sample, No. 27.

Fig. 2b : *Subbotina crociapertura* Blow. Spiral side. Sample, No. 27.

Fig. 2c : *Subbotina crociapertura* Blow. Edge side. Sample, No. 27.

Fig. 3a : *Subbotina hagni* (Gohrbandt). Umbilical side. Sample, No. 14 .

Fig. 3b : *Subbotina hagni* (Gohrbandt). Spiral side. Sample, No. 14 .

Fig. 3c : *Subbotina hagni* (Gohrbandt). Edge side. Sample, No. 14.

Fig. 4a : *Pseudohastigerina micra* (Cole). Umbilical side. Sample, No. 28 .

Fig. 4b : *Pseudohastigerina micra* (Cole). Spiral side. Sample, No. 28.

Fig. 4c : *Pseudohastigerina micra* (Cole). Edge side. Sample, No. 28.

Fig. 5a : *Turborotalia frontosa* (Subbotina). Umbilical side. Sample, No. 27.

Fig. 5b : *Turborotalia frontosa* (Subbotina). Spiral side. Sample, No. 27.

Fig. 5c : *Turborotalia frontosa* (Subbotina). Edge side. Sample, No. 27.

PLATE 2

