IOSR Journal of Applied Geology and Geophysics (IOSR-JAGG)
e-ISSN: 2321–0990, p-ISSN: 2321–0982.Volume 6, Issue 1 Ver. II (Jan. – Feb. 2018), PP 43-53
www.iosrjournals.org

Middle-Upper Eocene Benthic foraminiferal Biostratigraphy acrossCairo-Sukhna district, North Eastern Desert, Egypt

Magdy S. NASSIF [1] and Asmaa E. KORIN[2*]
[1]*Department of Geology, Facultyof Science, Suez Canal University. Ismailia, Egypt.*
[2] *Department of Geology, Faculty of Science, Port Said University, Egypt.*

Abstract: *The Middle and Upper Eocene rockswere carefully studied and sampled from three different geologic sections; WadiDegla, Gebel Abu-Shama and Gebel Qattamia across Cairo-Sukhna Road, North Eastern Desert, Egypt. These sections are subdivided into three main formations arranged from earliest to youngest; Observatory, Qurn and Maadi formations respectively. In terms of benthic foraminifera zonation, the study area yielded one benthic foraminiferal zone; Quinqueloculinaseminulum Zone. This zone includes three subzones arranged from oldest to youngest as follow: Quinqueloculinacarinata Subzone (Late Lutetian), UvigerinarippensisSubzone (Lutetian – Bartonian) and Textulariaadalta Subzone (Bartonian – Priabonian) respectively.*

Keywords:*Eocene, benthic foraminifera,biostratigraphy, eastern desert - Egypt.*

Date of Submission: 12-02-2018 Date of acceptance: 26-02-2018

I. Introduction

Biostratigraphic studies by means of benthic foraminifera of the Eocene rocks in Egypt have been studied by several workers [1], [2], [3], [4], [5], [6], [7], [8], [9], and [10]. The present study is concerned with establishment ofthe possible biostratigraphicbenthic foraminiferal biozones across the Middle-Upper Eocene rocks from three lithostratigraphic sections; WadiDegla, Gebel Abu-Shama and Gebel Qattamia sections acrossCairo-Sukhna district. Detailed studies of their foraminiferal distribution, occurrence, and thickness as well as correlating the biozones with their equivalents in North Eastern Desert and Egypt are achieved.

II. Study Area

The area under consideration (Fig. 1) was carefully examined to investigate the Middle and Upper Eocene outcrops. It lies between latitude 29°52'N and 29°59'N and longitude 31°20'E and 32°00'E and is bounded from the North by Cairo-Suez Road, Gebel Nasuri and Gebel Anqabiya, from the South by Gebel Ghreibun and Gebel Sad El-Naam, from the East by the Gebel Umm Ryhieat, Gebel Abu-Treifiya and Gebel Kiheilliya and from the West by Helwan city. It comprises three studied lithostratigraphic sections. The first section is called WadiDegla section, it is located at latitude 29°58'N and longitude 31°24'E east the nuclear materials authority building with thickness of 40m. WadiDegla section is affected by a number of normal faults in two main trends in the NW-SE and ENE-WSW directions [11]. The second section is called Gebel Abu-Shama section and is located south the Qattamia observatory building at latitude 29°52'N and longitude 31°38'E. Gebel Abu-Shamasection (Fig. 2) is considered as a slightly tilted faulted block of Eocene age and is a part of E-W elongated belts of the en echelon faults along Cairo Suez district i.e. the lateral movement on the deep-seated wrench faults in north Eastern Desert

[12]. The third section is called Qattamia section and is situated in the central part of the Cairo-Suez district at latitude 29°54'N and longitude 31°49'E with thickness of 62m. Qattamia section is a part of E-W elongated belt of the en echelon faults that extending 10km. there are number of NW oriented faults that bound several fault-blocks as horst, grabens and step faults [13].

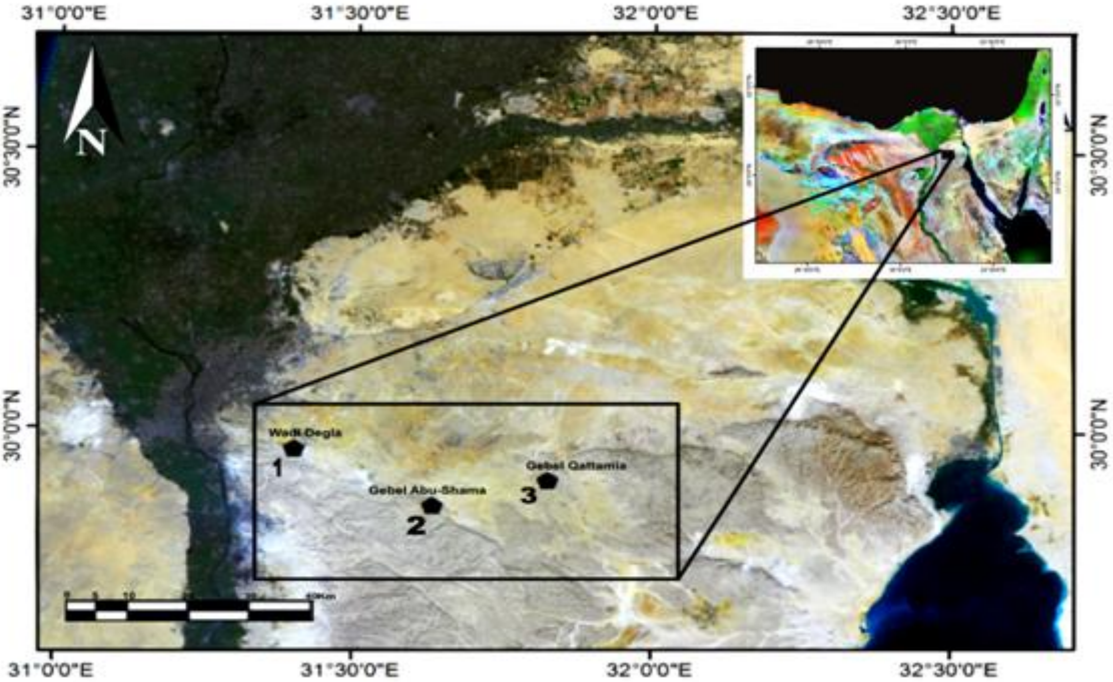


Fig 1. Satellite image from Google Earth of the study area and the localities of examined lithologic sections.

Fig. 2. Panoramic view of Gebel Abu-Shama section, North Eastern Desert, Egypt.

III. Methods

A total number of 121 representative samples were measured and sampled. A total of 34 rock samples were collected from WadiDegla, 49 from Gebel Abu-Shama and 38 rock samples from Gebel Qattamia. For benthic foraminifera examination, about 100-200 gm of dried rock samples were soaked overnight in a solution of hydrogen peroxide (H_2O_2 20%) until full disintegration and washed over a 63 µm sieve. This process was repeated under a gentle current of water, the residue was then dried in sand bath. The microfossil content were picked and separated into foraminifera and ostracod then, identified by using binocular microscope with magnification 10, 20, and 40X. All the identified benthic foraminifera were photographed by the Scanning Electronic Microscope (SEM) model at the Geological Survey of Egypt.

IV. Lithostratigraphy

The field study has enabled to recognize three rock units representing the Middle and Upper Eocene sedimentary rocks in North Eastern Desert as following from the oldest to youngest:

4.1 Observatory Formation

The term Observatory was first introduced by [14]. In the study area, The base of the Observatory Formation is unexposed and located in the three studied sections with different thicknesses; 22m in WadiDegla, 48m in Gebel Abu-Shama and 34 m in Gebel Qattamia. It is overlain conformably by Qurn Formation and composed of grayish to yellowish white nodular nummulitic limestone (Fig. 3a), with brownish white cavernous siliceous limestone interbedded by dolomitic beds.

The stratigraphic position with the faunal content assigned the Observatory Formation to the middle Eocene. It is considered to be of Lutetian age by many researchers such as [1], [9], [14], [15], [16], [17], [18], [19], [20], [21], [22], [23], and [24].

In Sinai,particularlyGebel Nukhul, Observatory Formation is correlated to the upper Khaboba Formation [25] and[26]. Furthermore, it is equivalent to El-Ramiya Formation at Gebel Ataqa[27] and Sannor Formation [28] in the Nile Valley. Sath El-Hadid Formation and El-Gharaq Formation [29] and [30] in the Fayoum Province are correlated with Observatory Formation. Moreover, the lower part of Hamra Formation [31] and [32] at Northern Bahariya Plateau could be correlated to Observatory Formation (Table.1).

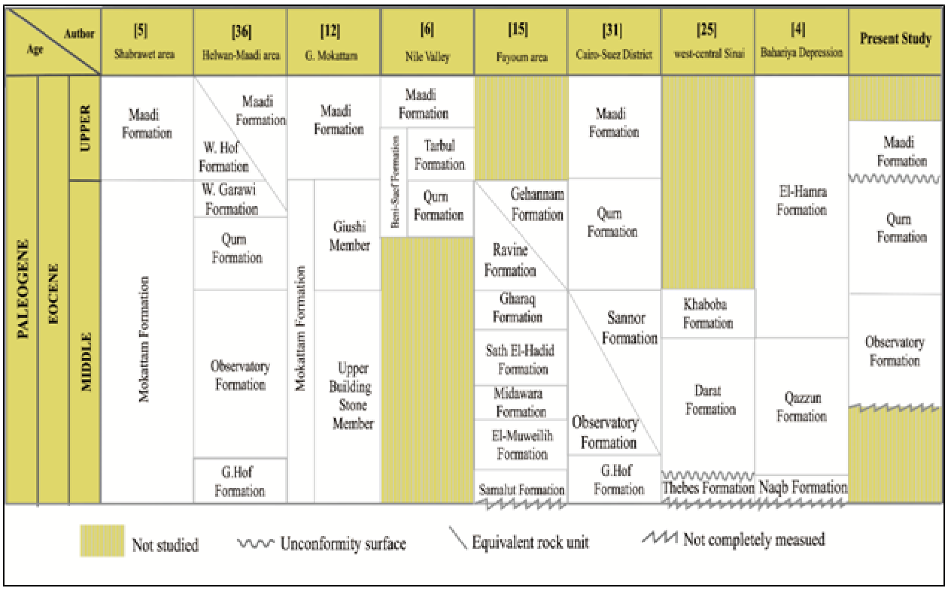
4.2 Qurn Formation

Qurn Formation overlies conformably the Observatory Formation and named as Qurn by [14]. It is recorded in the three studied sections with relatively various thickness; 17m in WadiDegla, 18m in Gebel Abu-Shama and 28 m in Gebel Qattamia. The lower parts are composed of yellowish white marly limestones (Fig. 3b) while it is composed of chalky limestone with interbeds of varicolored shales at the upper parts. The stratigraphic position with the faunal content assigned the Qurn Formation to the middle-upper Eocene (Bartonian)[14], [17] and[33].Qurn Formation correlates with Gehannam Formation in the Fayum area [34]. It is also equivalent to the lower part of Tanka Formation [35] at Gebel Tanka, West-Central Sinai. In BeniSuef the Qurn Forms the upper member of El-Fashn Formation [36] while in the BeniMazar area, El-Merier Formation [37] correlates with it (Table.1).

4.3 Maadi Formation

Maadi Formation overlies unconformably the Qurn Formation in Gebel Abu-Shama only. It is composed mainly of varicolored clastic sediments, shales, sandstones and fossiliferous yellowish white marly limestones with Caroliaplacunoidescantraine(Fig. 3c) and other oyster banks. The faunal content assigned the Maadi Formation to the upper Eocene (Priabonian). The Maadi Formation was assigned to be of Late Eocene by many works such as [38], [20], [39], [3] and [24]. It correlates with the Wadi Hof Formation [14] in Helwan and Giza Pyramids areas (Table.1), the Qasr El-Sagha Formation [34] in the Fayoum, the upper Hamra Formation [31] in the Bahariya Oasis.

Table 1: Correlation of the middle and upper Eocene rock units across Egypt.



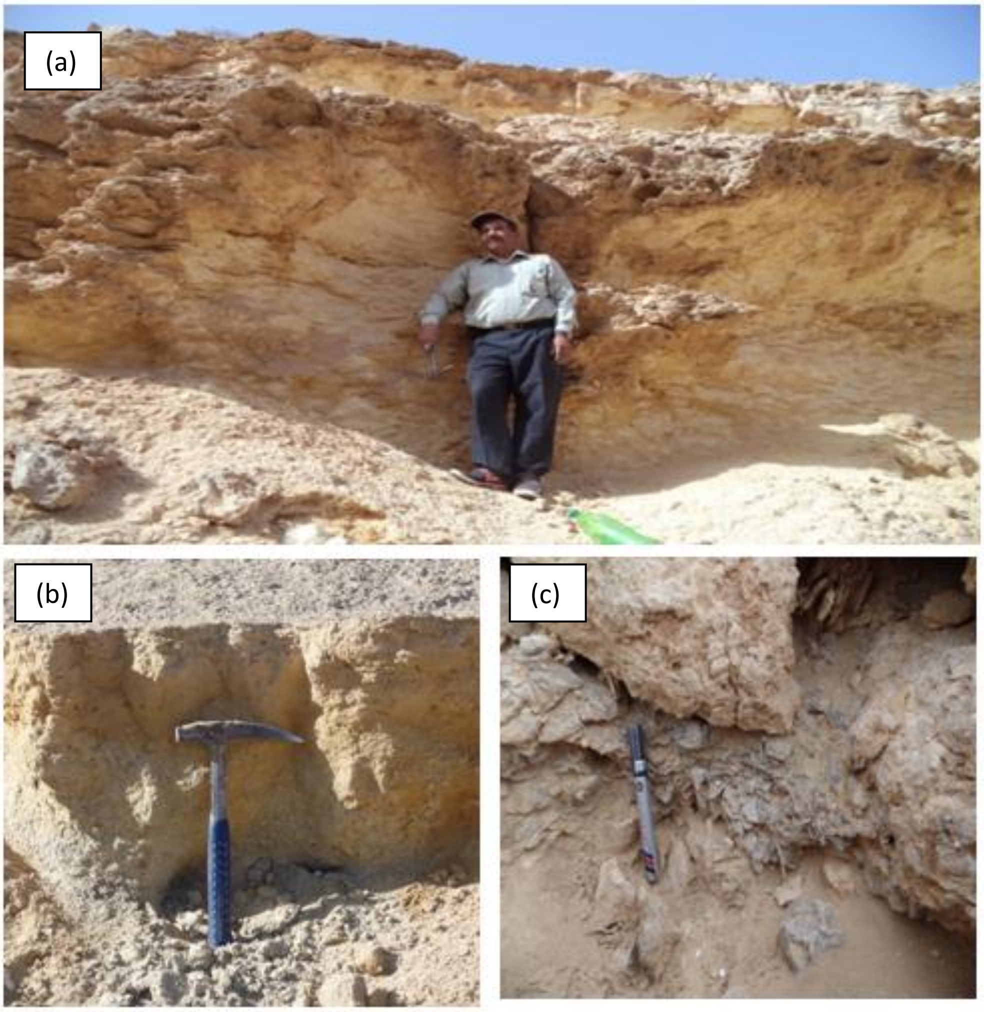


Fig. 3. a: Thickly bedded nodular nummulitic limestone of the Observatory Formation in Gebel Abu-Shama section. b: marly limestone bed of the Qurn Formation at Gebel Qattamia. c: fossiliferous yellowish white marly limestones with CaroliaplacunoidesCantraine and other oysters in Gebel Abu-Shama.

4.4Thickness and lithological analysis.

The comparable analysis of the rock units of the middle-upper Eocene succession in the area under concern indicates that there are differences in both thickness and lithology of the examined sections in WadiDegla, Gebel Abu-Shamaand Gebel Qattamia. The thickness of the Eocene succession at G. Abu-Shama exceeds 40m than WadiDegla with distance between them about 22km while it exceeds 17m than that at G. Qattamia with distance between them 18Km.The stratigraphic correlation of the examined formations (Fig.4) showed that the early Eocene units not completely measured as they are unexposed well on the ground surface. The Observatory Formation at Gebel Abu-Shama attains maximum thickness exceeds 26.2m than the Observatory Formation at WadiDegla and exceeds 14m than the Observatory Formation at Gebel Abu-Shama. The Qurn Formation at Gebel Qattamia exceeds 10 m than the Qurn Formation of both Gebel Abu-Shama and WadiDegla and . The Maadi formation only recorded in the Abu-Shama section unconformably overlain the Qurn Formation with thickness of 12.5m.

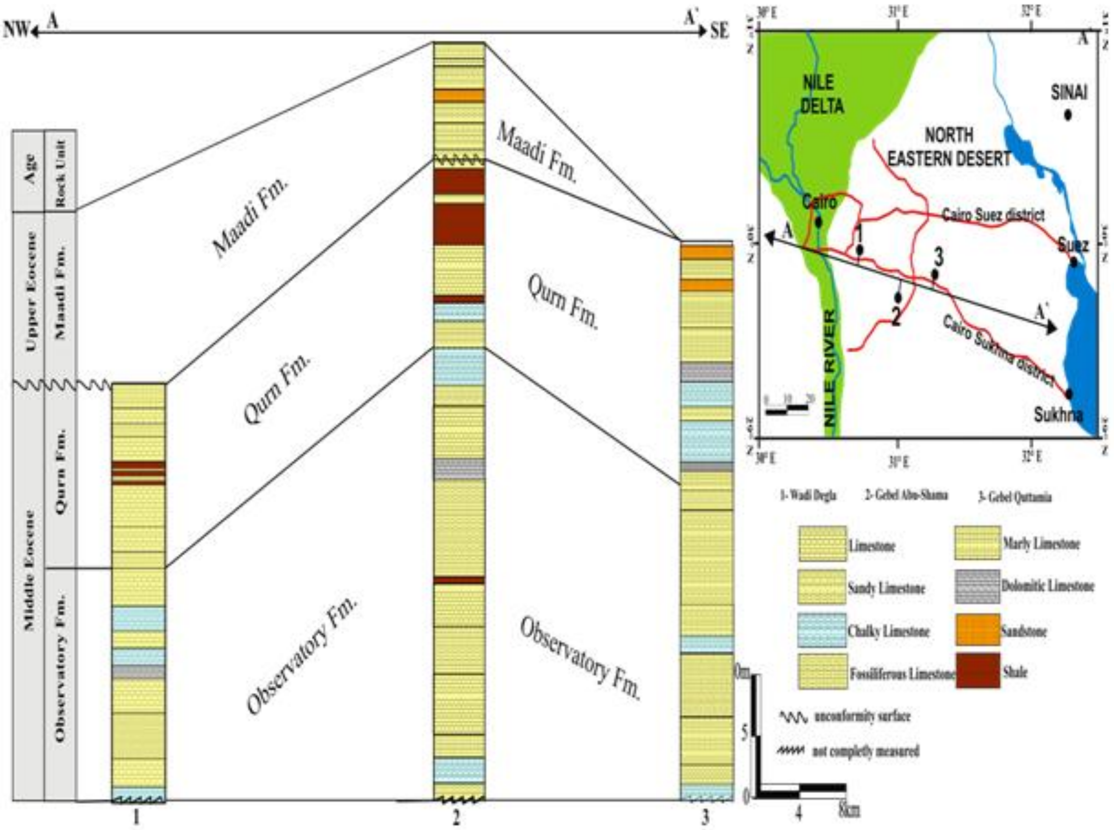


Fig. 4: The stratigraphic correlation of the studied sections.

V. Biostratigraphy

Benthic foraminifera are occurred continuously with common, abundant or even rare which can be practically used to subdivide the successions into one benthic Zone and three subzones as following:

5.1 Quinqueloculinaseminulum Zone

Category**:** Taxon-range Zone.

Age**:** Middle Eocene (Lutetian-Bartonian) to Late Eocene (Priabonian).

Definition**:** range from the first occurrence of *Quinqueloculinaseminulum*(Linné) to the last occurrence of the same species.

OccurrenceandThickness: This zone is recorded in WadiDegla, Gebel Abu-Shama and Gebel Qattamia. It is measured 39.2 m in WadiDegla, 79.6m in Gebel Abu-Shama and 62.2m in Gebel Qattamia. It is subdivided into three subzones in both WadiDegla and Gebel Abu-Shama while, it could not be subdivided in Gebel Qattamia (Fig. 5) due to the absence of benthic marker species.

5.1.1. Quinqueloculinacarinata subzone

Category**:** Interval subzone.

Age**:** Middle Eocene (Lutetian).

Definition**:** Interval subzone from the first occurrence of *Quinqueloculinacarinata*d'Orbignyto the first occurrence of *Uvigerinarippensis*Cole.

OccurrenceandThickness: This subzone is recorded from the basal part of the Observatory Formation in WadiDegla with thickness of 12.75m and Gebel Abu-Shama with thickness of 22.9m.

Characteristicspecies**:** Species first appeared within this subzone (figs. 6-7) are Quinqueloculina carinata d'Orbigny, Cibicides beaumontianus (d'Orbigny), Globulina gibba d'Orbigny, Pseudolacazina schwagerinoides (Blanckenhorn), Elphidium texanum (Cushman and Applin), Quinqueloculina seminula (Linné), Periloculina dalmatina Drobne, Operculina libyca thebensis Hamam, Spiroplectinella carinata (d'Orbigny), Idalina cuvillieri Bignot, Nummulites pulchellus (Hantken), Nummulites thalmanni (Schaub), Triloculina gibba d'Orbigny,Nummulites beaumonti d'Archiac and Haime, Pyrgo elongata (d'Orbigny), Lagena sulcata (Walker and Jacob, Textularia dibollensis Cushman and Applin, Gyroidina soldanii d'Orbigny, Elphidium excavatum (Terquem), Guttulina problema d'Orbigny, Spiroloculina canaliculata d'Orbigny, Bulimina elongata d'Orbigny, Anomalinoides alazanensis (Nuttall), Textularia tumidulum Cushman, Uvigerina cocoaensis Cushman, Elphidium rugosum (d'Orbigny), Bolivina gracilis Cushman and Appline, Lenticulina turbinate (Plummer), Clavulinoides alpina Cushman, Fursenkoina dibollensis (Cushman and Applin), Uvigerina elongata Cole, Lenticulina rotulata (Lamarck), Ammodiscus latus Grzybowski, Cibicides lobatulus (Walker and Jacob), Eponides ellisorae Garrett, Lagena striata (d'Orbigny), Brizalina cookei (Cushman), Eponides lotus (Schwager), Spiroplectammina (Spiroplectinella) carinata (d'Orbigny), Baggina bradyi (Brotzen).

Correlation*:Quinqueloculina carinata* subzone is equivalent to the *Nummulites* cf. *syrticus* Zone as described by [10] from North Eastern Desert (Table 2). It is correlated with *Uvigerina nakkadyi – Anomalinoides fayoumensis* Zone of the middle Eocene recorded by [5] at East Beni Mazar area, Nile Valley. It could be correlated with *Marginulinopsis* cf. *fragaria* Zone of Eocene rocks recognized by [2] in the West Central Sinai (Table 2). In addition to, it is correlated with *Norcottia danvilensis – Altistoma aegyptiaca* Zone of Middle Eocene successions defined by [8] in western Sinai. It is also correlated with the *Nummulites* aff. *Puchellas* Zone described by [6] from the Observatory Formation in Helwan area. The identified *Quinqueloculina carinata* subzone in the study area is equated with the lower part of the *Bulimina jacksonensis - Uvigerina jacksonensis* Zone that described by [7] from Gebel Mokattam, Greater Cairo (Table 2). It is correlated with the lower part of *Dictyoconus egyptiensis – Nummulites beaumonti* Zone introduced by [2] of middle Eocene in area South Cairo-Suez district (Table 2). It is equivalent to the lower part of *Bulimina jacksonensis* that described by [9] in the Eocene rocks North Eastern desert (Table 2). It is also correlated with the lower part of the *Palmula ansaryi* Zone that introduced by [3] of the Eocene rocks in Wadi Bayad El-Arab area at Beni Suef, Nile Valley.

5.1.2.Uvigerinarippensis Subzone

Category: Interval subzone.

***Age*:** middle Eocene (Lutetian – Bartonian).

Definition: interval subzone from the first occurrence of *Uvigerinarippensis*Coleto the first occurrence of *Textulariaadalta*Cushman.

OccurrenceandThickness: This subzone is recorded from the middle to the upper part of the Observatory Formation in WadiDegla (Fig. 6) and measures about 19.3m. Whereas, it attains 36.8m at Gebel Abu-Shama (Fig. 7) and extends from the upper part of the Observatory Formation to the lower part of Qurn Formation.

***Characteristicspecies*:** Species first appeared (figs. 6-7) within this subzone are *Uvigerina rippensis* Cole, Gyroidina *soldanii* d'Orbigny, *Pyrgo bulloides* (d'Orbigny), *Cibicides carinatus* (Terquem), *Stilostomella curvatura* (Cushman), *Lenticulina chitanii* (Yabe and Asano), *Dentalina* sp. and *Nodosaria sp.*, *Bulimina jacksonensis* Cushman, *Stilostomella curvatura* (Cushman), *Spiroloculina bicarinata* Terquem, and *Baggina bradyi* (Brotzen)(Fig. 5). While, species undergoes disappearance are *Cibicides beaumontianus* (d'Orbigny), *Nummulites beaumonti* d'Archiac and Haime, *Eponides lotus* (Schwager), *Elphidium rugosum* (d'Orbigny), *Lagena striata* (d'Orbigny), *Textularia dibollensis* Cushman and Applin, *Ammodiscus latus* Grzybowski, *Lagena vulgaris* Williamson, *Eponides ellisorae* Garrett, *Uvigerina cocoaensis* Cushman, *Fursenkoina dibollensis* (Cushman and Applin), *Clavulinoides alpina* Cushman and *Bolivina gracilis* Cushman and Appline. In addition to, species continue from the underlying subzone to the following subzone are *Elphidium excavatum* (Terquem), *Quinqueloculina carinata* d'Orbigny,), *Elphidium texanum* (Cushman and Applin), *Brizalina cookei* (Cushman), *Bolivina moodysensis* Cushman and Todd, *Anomalinoides alazanensis* (Nuttall), *Textularia tumidulum* Cushman, *Lenticulina rotulata* (Lamarck), *Uvigerina elongata* Cole and *Uvigerina jacksonensis* Cushman.

Correlation*:Uvigerina rippensis* subzone is correlated with *Fabularia schwagerinoudes* Zone and *Idlaina* cuviellieri Zone as recorded [10] from the middle Eocene rocks at North Eastern Desert (Table 2). It coincides with *Brizalina cookie* and *Nonion scaphum - Pararotalia audouini* zones as defined by [5] from the middle Eocene of the Nile Valley. It is also equated with the *Uvigerina continuosa*/*Eponides* cf. *haeringensis* and *Uvigerina eocaena - Uvigerina steyeri* zones of the middle Eocene as introduced by [3] in the west central Sinai (Table 2). It is correlated with *Uvigerina rippensis - Uvigerina churchi* Zone, recorded by [8] in western Sinai. It is also correlated with *Nummulitesbullatus* Zone and *Nummulites* cf. *beaumonti-Nummulites* aff. *pulchellus* assemblage Zone as defined by [6] from the Qurn Formation in Helwan area (Table 2). *Uvigerina rippensis* subzone is also equivalent to the middle part of *Bulimina jacksonensis - Uvigerina jacksonensis* Zone as recognized by [7] in the Mokattam area (Table 2).It coincides with theupper part of *Dictyoconus egyptiensis – Nummulites beaumonti* Zone to *Nummulites* cf. *beaumonti - Nummulites striatus* Zone, presented by [1] in the middle Eocene rocks at an area located at south Cairo-Suez district. It is correlated with the upper part of *Bulimina jacksonensis* Subzone to *Uvigerina mediterranea* Subzone that described by [9] from the middle Eocene rocks of North Eastern Desert (Table 2). It is equivalent to the middle and upper part of the *Palmula ansaryi* Zone that studied by [3] of the Eocene rocks in Wadi Bayad El-Arab area at Beni Suef, Nile Valley.

5.1.3Textulariaadalta subzone

Category**:** concurrent range subzone.

Age**:** middle to late Eocene (Bartonian – Priabonian).

Definition**:** concurrent range zone from the first occurrence of *Textulariaadalta*Cushman and the last occurrence of *Lagenahexagona* (Williamson).

OccurrenceandThickness: This subzone is recorded from the lower part of the Qurn Formation in WadiDegla and attains 8m. Whereas; it attains 16m at Gebel Abu-Shama and extends from the upper part of the Qurn Formation to the lower part of Maadi Formation.

Characteristicspecies**:** *Textulariaadalta*Cushman, *Quinqueloculinaludwigi*Reuss, *Bagginabradyi* (Brotzen), *Guttulinaproblema*(d'Orbigny), *Lagenahexagona* Williamson (figs. 6-7).

Correlation**:***Textulariaadalta* subzone is correlated with *Caroliaplacunoides* Zone that presented by [40] in the upper Eocene succession at Gebel Akheider, Gulf of Suez. It is also equivalent to *Nummulites* sp. gr. *incrassatus* Zone recorded by [6] from the Qurn Formation in Helwan area (Table 2). It is also correlated to *Quinqueloculinacarinata* Zone which presented by [1] from upper Eocene sediments at northeast Gebel Ghraibun, South Cairo-Suez district. It is correlated to *Buliminajaksonensis* Zone that recorded by [3] of the Eocene rocks in WadiBayad El-Arab area at BeniSuef, Nile Valley (Table 2).

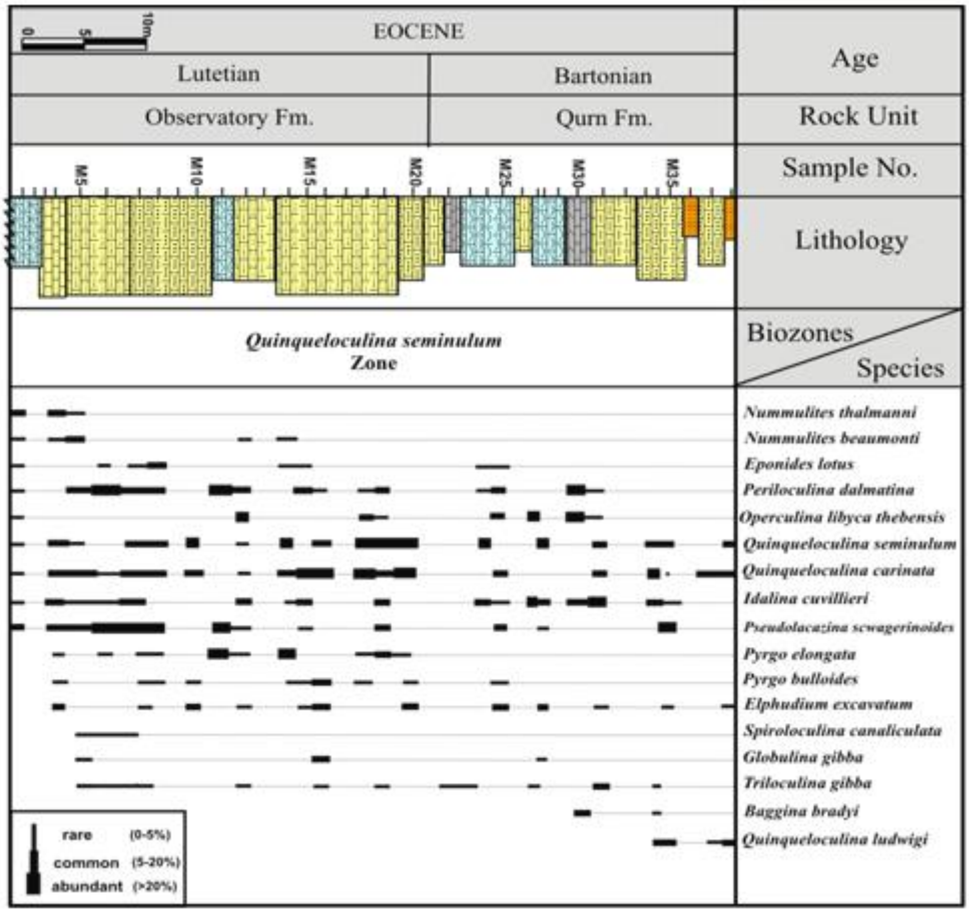


Fig. 5. Benthic foraminiferal distribution chart of the identified species in Gebel Qattamia.

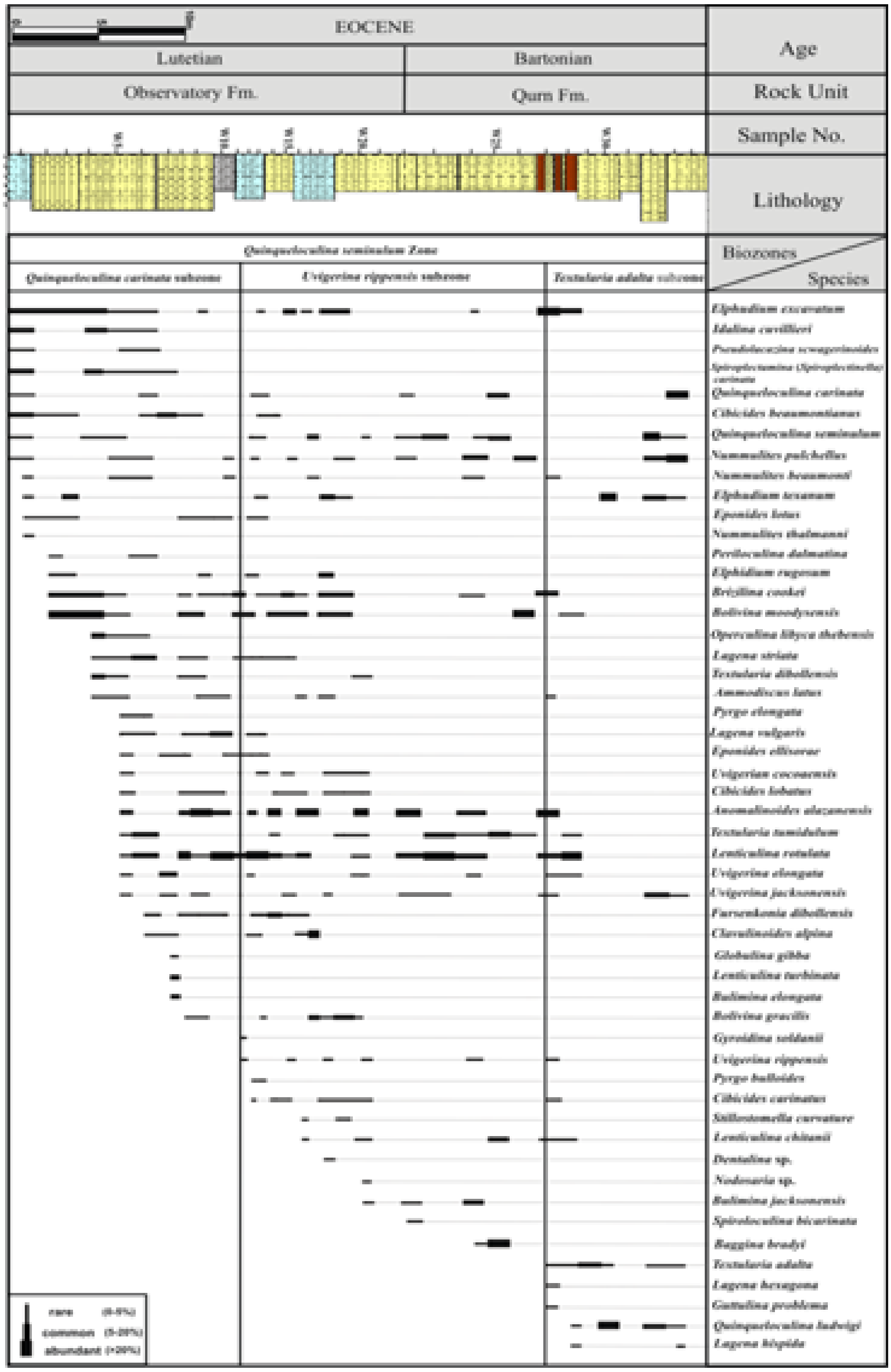


Fig. 6. Benthic foraminiferal distribution chart of the identified species in WadiDegla.

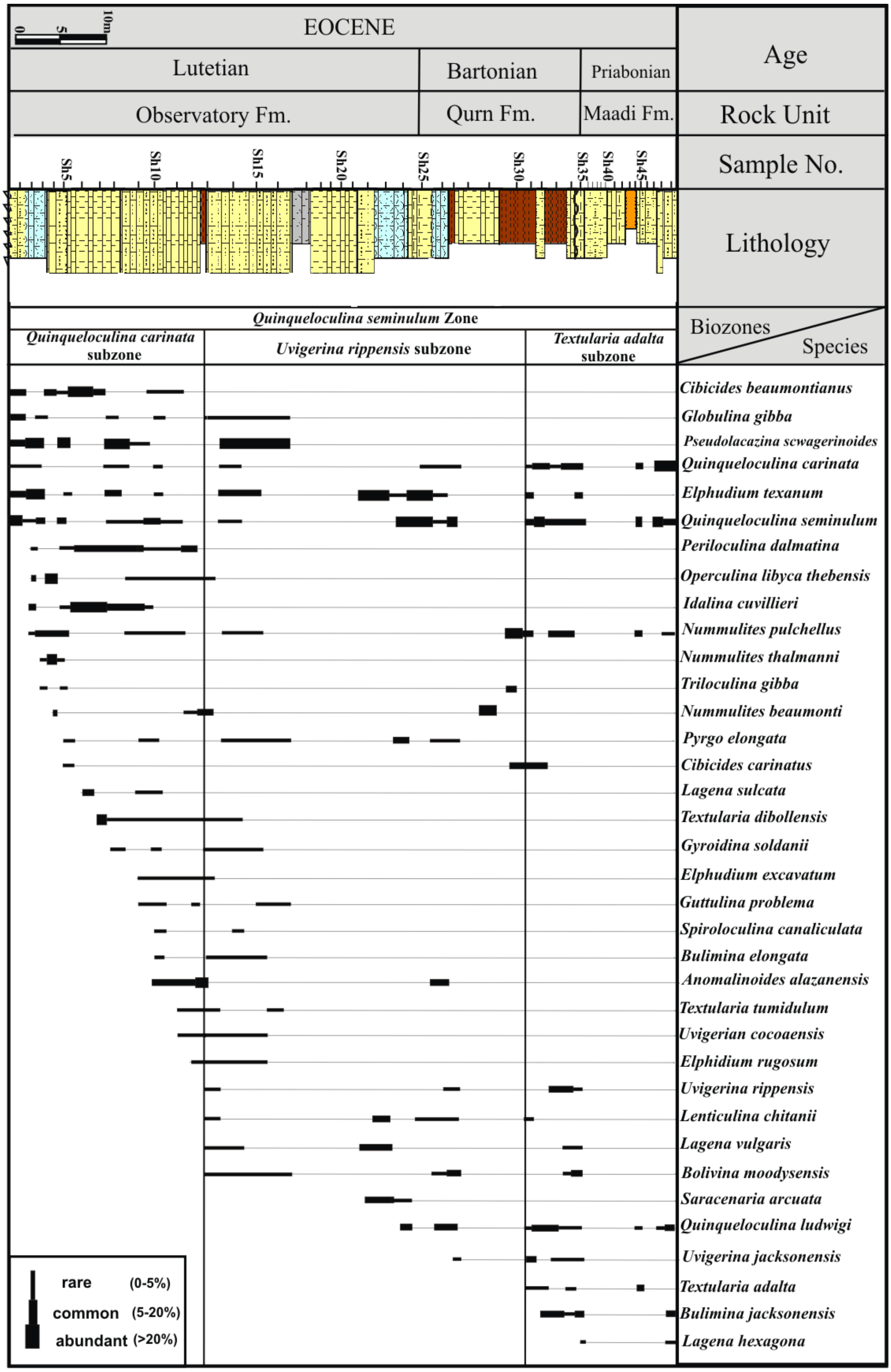


Fig. 7. Benthic foraminiferal distribution chart of the identified species in Gebel Abu-Shama.

Table 2. Correlation chart of the foraminiferal biozones in the study area and theirequivalents in Egypt.

Epoch		Age	[37] North Eastern Desert	[16] East Beni Mazar area, Nile Valley	[3] Western Sinai	[32] Western Sinai	[12] Helwan area	[17] Gebel Mokattam	[2] South Cairo-Suez District	[33] Qattamia area		[6] Wadi Bayad, Beni-Suef, Nile Valley	Present Study	
EOCENE	UPPER	Priabonian					*Nummulites* Sp. gr. *incrassatus*		*Quinquiloculina carinata*			*Bulimina jacksonensis*	*Quinquiloculina seminulum*	*Textularia adalta*
	MIDDLE	Bartonian	*Idalina cuvillieri*	*Nonion scaphum-Pararotalia audouini*	*Uvigerina eocaena-Uvigerina steyeri*	*Uvigerina rippensis / Uvigerina churchi*	*Nummulites* cf. *beaumonti/ Nummulites* aff. *pulchellas*	*Bulimina jacksonensis/ Uvigerina jacksonensis*	*Nummulites* cf. *beaumonti/ Nummulites striatus*	*Bulimina jacksonensis/ Uvigerina jacksonensis*	*Uvigerina mediterranea*	*Palmula ansaryi*		*Uvigerina rippensis*
			Fabularia schwagerinoides	*Brizalina cookei*	*Uvigerina continuosa/ Eponides* cf. *haeringensis*		*Nummulites bullatus*		*Dictyoconus egyptiensis/ Nummulites striatus*		*Bulimina jacksonensis*			
		Lutetian	*Nummulites* cf. *syrticus*	*Uvigerina nakkadyi/ Anomalinoides fayoumensis*	*Marginulinopsis* cf. *fragaria*	*Norcottia danvilensis/ Altistoma aegyptiaca*	*Nummulites* aff. *puchellas*		*Dictyoconus egyptiensis/ Nummulites beaumonti*					*Quinquilocul-ina carinata*

not studied.

VI. Conclusion

An attempt to establish the biostratigraphic benthic foraminiferal biozones across the Middle-Upper Eocene in the northeaster desrt of Egypt has been carried out. Three lithostratigraphic sections were recorded; WadiDegla, Gebel Abu-Shama and Gebel Qattamia sections across Cairo-Sukhna district. Detailed studies of the foraminiferal distribution, occurrence, and thickness of the selected section was perfomed as well as correlating the biozones with their equivalents in North Eastern Desert and Egypt.

The middle-upper Eocene rocks in the area was subdivided into three main formations arranged from oldest to youngest; Observatory, Qurn and Maadi formations. In terms of benthic foraminifera zonation, the study area is yielded 1 benthic foraminiferal zone; Quinqueloculinaseminulum Zone. This zone includes three subzones arranged from oldest to youngest as following, Quinqueloculinacarinata Subzone (Late Lutetian), Uvigerinarippensis Subzone (Lutetian – Bartonian) and Textulariaadalta Subzone (Bartonian – Priabonian).

References

[1] Abu-Ellil, M. M., 2004. Stratigraphy of the Middle Eocene rocks in the area of Qattamia – Northern Galala stretch, north Eastern Desert, Egypt. Ph. D. Thesis, Fac. of. Sci., Zagazig Univ., 236pp.

[2] Abul-Nasr, R.A., 1992. Paleoecology and Sedimentary Environments of Middle-Upper Eocene Rocks in West Central Sinai, Egypt.-M.E.R.C. Ain Shams Univ., Earth Sci. Ser., 6: 126-138.

[3] Aly. H., Abel-Aziz, S. and Abel-Gaied, I., 2011. Middle and Upper Eocene benthic foraminifera from WadiBayad El Arab-Gebel HomretShaibon area, northeastern BeniSuef, Nile Valley, Egypt. Egypt. Jour. Paleontol., 11, 79-131.

[4] Ansary, S. E. and Ismail, M. M., 1956. The determination of the Middle-Upper Eocene boundary in the area east of Helwan as indicated by foraminifera. Bull. Inst. Desert d'Egypte, 6(1), 185-192.

[5] El-Dawy, M. H., 1997. Middle Eocene benthic foraminiferal biostratigraphy and paleoecology of east BeniMazar area, Nile Valley, Egypt. Egyptian Journal of Geology, 41(1), 413-464.

[6] Boukhary, M., Hussein, A. and El-Morcey, I. A., 2002. Eocene larger foraminifera from Helwan, Greater Cairo, Egypt. Revue de Micropaléontologie, 45(1), 27-45.

[7] Elewa, A. M., 2004. Quantitative analysis and palaeoecology of Eocene Ostracoda and benthonic foraminifera from Gebel Mokattam, Cairo, Egypt. Palaeogeography, Palaeoclimatology, Palaeoecology, 211(3), 309-323.

[8] Shahin, A., 2000. Biostratigraphic significance, paleobiogeography and paleobathymetry of Tertiary Buliminacea and Bolivinacea in the Western Sinai, Egypt. Neues J ahrbuchfürGeologie und Paläontologie, Abhandlungen, 216(2), 195-231.

[9] Shahin, A., Bassal, A., El-Halaby, O. and El-Baz, S., 2007. Middle Eocene Benthic foraminiferal biostratigraphy and paleoenvironment at the Qattamia area, Northern Eastern Desert, Egypt. Egypt. Jour. Paleontol., 7, 29pp.

[10] Strougo, A., Bignot, G. andAbd-Allah, A. M., 1992. Biostratigraphy and paleoenvironments of Middle Eocene benthonic foraminiferal assemblages of northcentral Eastern Desert, Egypt.). M.E.R.C., Ain Shams Univ., Earth Sci. Res., 6, 1-12.

[11] Wagdy, A., El Adway, H. and El-Gamal, M., 2008. Vegetation dynamics assisted hydrological analysis for WadyDegla. UNDP/GEF/Cairo University, 87pp.

[12] Youssef, M. I., 1968. Structural pattern of Egypt and its interpretation. American Association of Petroleum Geologists Bulletin, 52, 601-614.

[13] Hagag, W., 2016. Structural evolution and Cenozoic tectonostratigraphy of the Cairo-Suez district, north Eastern Desert of Egypt: Field-structural data from Gebel Qattamiya-Gebel Um Reheiat area. Journal of African Earth Sciences, 118, 174-191.

[14] Farag, I. and Ismail, M. M., 1959. Contribution to the stratigraphy of the Wadi Hof area (northeast of Helwan). Bull. Fac. Sci. Cairo. Univ. 34, 147-168.

[15] Hassaan, M., El Badry, O., Mohammad, M., Atawiya, M., and Zalat, A., 1984. Petrographical and geochemical studies on the tertiary rock units of the area East of Maadi, Egypt. M.E.R.C., Ain Shams Univ., Earth Sci., Res., 4, 207-238.

[16] Kolkila, A., Mohammed, M. andMahran, M., 1984. Microfacies and depositional environment of the Middle Eocene sequence in the area to the west of Helwan, Egypt. An. Geol. Surv. Egypt, 14, 257-268.
[17] Said, R., 1990. The Geology of Egypt, Belkema, Rotterdam, Berlin, 734pp.
[18] Strougo, A. and Abd-Allah, A., 1990.Mokattamian stratigraphy of northern Eastern Desert (South of Maadi – Qattamia road). M.E.R.C., Ain Shams Univ., Earth Sci. Res., 4, 152-175.
[19] Moustafa, A. andAbd-Allah, A., 1991. Structural setting of the central part of the Cairo-Suez district. M.E.R.C., Ain Shams Univ., Earth Sci. Res., 5, 133-145.
[20] Strougo, A., 1985. Eocene stratigraphy of the Eastern Greater Cairo (Gebel Mokattam – Helwan) area. M.E.R.C., Ain Shams Univ., Earth Sci. Res., 5, 39pp.
[21] Morsi, A., M., 1991. Stratigraphic and ecologic evaluation of the Eocene rocks in the area southwest of the Cairo-Suez road. Unpublished M. Sc. Thesis, Ain Shams Univ., 201pp.
[22] Galal, A. and El-Halaby, O., 2002. Taxanomy and foraminiferal biostratigraphy of the Minia Formation in WadiQena and WadiAgramyia North Eastern Desert, Egypt. An. Geol. Surv. Egypt, 24, 24pp.
[23] Bignot, G. and Strougo, A., 1994. Middle Eocene lagoonal benthic foraminiferal assemblages in the Eastern Desert of Egypt and south Tethyan counterparts. Bollettino-SocietaPaleontologicaItaliana, 33, 41-46.
[24] Sallam E., Issawi B. and Osman, R., 2015. Stratigraphy, facies and depositional environments of the Paleogene sediments in Cairo-Suez district, Egypt. Arab. J. Geosci., 8, 1939–1964.
[25] Morsi, A., Hewaidy, A. and Samir, A., 2016. New marine ostracod species from the Middle Eocene of west-central Sinai, Egypt. Journal of African Earth Sciences, 117, 150-159.
[26] Viotti, C. and El-Demerdash, G., 1969. Studies on Eocene Sediments of WadiNukhul Area, East Coast-Gulf of Suez. Proceedings of the 3rd Afric. Micropal. Colloq., 3, 403-423.
[27] El-Akkad, S. and Abd-Allah, A. M., 1971. Contribution to the geology of Gebel Ataqa area. An. Geol. Surv. Egypt, 1, 21-42.
[28] Boukhary, M. and Abdelmalik, W., 1983. Revision of the stratigraphy of the Eocene deposits of Egypt, N. Jb. Geol. Paläontol. Mh., 6, 321–337.
[29] Iskander, F., 1943. Geological survey of the Gharaq El-Sultani sheet no. 68/54. Standard Oil company, Egypt sa, reports, 57, 1-29.
[30] El Ghar, M. S., 2012. Sequence stratigraphy and cyclicity in the Middle Eocene of the Fayoum ranges, Western Desert, Egypt: Implications for regional sea level changes. Marine and Petroleum Geology, 29(1), 276-292.
[31] Said, R. and Issawi. B., 1965. Geology of northern plateau, Bahariya Oasis. Egypt. Egypt. Geol. Surv., 29, 41pp.
[32] Afify, A.,SerrA-Kiel, J., Sanz-Ero, M, Calvo, J. and Sallam, E., 2016. Nummulite biostratigraphy of the Eocene succession in the Bahariya Depression, Egypt: Implications for timing of iron mineralization. Jour. Afri. Ear. Sci., 120, 44-55.
[33] Strougo, A. andBoukhary, M., 1987. The Middle Eocene-Upper Eocene boundary in Egypt: present state of the problem. Revue de Micropaléontologie., 30(2), 122-127.
[34] Beadnell, H. J., 1905. The topography and geology of the Fayoum province of Egypt. An. Geol. Surv. Egypt, 101pp.
[35] Hume, W. F., Madgwick, T. G., Moon, F. W. andSadek, H., 1920. Preliminary geologic report on Gebel Tanka area. Petr. Res. 4, 1-16.
[36] Bishay, Y., 1966. Studies on the larger foraminifera of the Eocene of the Nile Valley between Assiut, Cairo and S.W. Sinai. Unpublished Ph.D. Thesis, Alexandria University, Egypt.
[37] Omara, S., Mansour, H., Youssef, M. and Khalifa, H., 1977. Stratigraphy, paleoenvironment and structural features of the area east of BeniMazar, Upper Egypt. Bull. Fac. Sci. Assiut. Univ., 6(3), 171–97.
[38] Al-Ahwani, M. M. 1980. Geological and sedimentological studies of Gebel Shabraweet area, Suez Canal District, Egypt. An. Geol. Surv. Egypt, 12, 305-381.
[39] Boukhar y, M., El Safori, Y.A., Decroue z, D. and Faris, M., 2006. Bio- and isotope stratigraphy of the Lower/Middle Eocene section at Gebel Hafit area, United Arab Emirates.– N. Jh. Geol. Palaont. Mh., 3, 129–147.
[40] Abd-Elshafy, E., Abed, M. and Shahat, W., 1989. Stratigraphic correlation and macropaleontology of Akheider-Um Zeita Eocene successions, Gulf of Suez Egypt. Proc. Symp. Phanerozoic and Development in Egypt, National Committee of Geological Sciences and Al-Azhar University, 79-106.

Magdy S. NASSIF "Middle-Upper Eocene Benthic foraminiferal Biostratigraphy acrossCairo-Sukhna district, North Eastern Desert, Egypt." IOSR Journal of Applied Geology and Geophysics (IOSR-JAGG) 6.1 (2018): PP 43-53.