Agglutinated Foraminiferal Morphogroups across the Paleocene- Eocene Boundary at Wasif Section, Safaga Area, Eastern Desert, Egypt

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Abstract: Analysis of agglutinated foraminiferal morphogroupsin Paleocene-Early Eocene deposits at Wasif section, Safaga area, Eastern Desert, Egypt, was carried out. The Paleocene-Eocene succession at Wasif section containsmoderately-diverseof agglutinated foraminiferal assemblages. Three morphogroups were differentiated within the foraminiferal assemblages based on shell architecture (general shape, mode of coiling and number of chambers), the microhabitat (epifaunal, shallow infaunal and deep infaunal) and feeding strategy (suspension-feeder). The environment of the analysed section is interpreted, in a sequence stratigraphic framework, using a combination of the stratigraphic distribution of morphogroups, species diversityand sedimentary data. The decreasing trend in tubular, elongate keeled and elongate subcylindrical forms towards the top part of the Esna Shale Formation might indicates on the shallowing regional bathymetry around the Paleocene-Eocene boundary.

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1. Introduction

The northern Red Sea is important to geologists because of its location at the junction of the African and Arabian plates. The Safaga area is occupied by relatively low hills of sedimentary rocks surrounded by mountain of igneous and metamorphic rocks. Wasif area an oval shapedare, lies about 25 km southwest to the Port of Safaga, Eastern Desert, Egypt. The Wasif area is one of many economic areas that distinguish the southern part of Eastern desert. The studied section is locatedsouth east Um El Huetat, between 26° 30' 52", 26° 31' 39" N and 33° 35' 02", 33° 56' 12" E (Fig. 1). Previous studies that dealt with geology, macrofossils, micropaleontology, mainly of planktonic foraminifers and nannofossils, sedimentology, and stratigraphy on the upper Cretaceous-lower Tertiary successions have been made on the Quseir Safaga district (e. g., Barron & Hume, 1902: Ball, 1913: Said, 1962; Omara, 1965: Akkad and Dardir, 1966: Abdel Razik, 1967: Hewaidy, 1979 and Hewaidy & Faris, 1989).

The term morphogroups refers to broad groupings of similar shapes or growth patterns of tests regardlesstheir taxonomy (Murray *et al*., 2011). In the last two decades, morphogroups have been increasingly used in palaeoenvironmentaland paleobathymetricreconstructions (e. g. Jones and Charnock, 1985; Kaminski *et al*., 1995; Nagy *et al*.,2000, 2009; and Murray *et al*., 2011). Johnes and Charnock (1985) proposed a classification of deep-water agglutinated foraminifera (DWAF) morphogroups based on their test shape and chamber arrangement. Benthic foraminiferal assemblage structures are also used as indicators for physical and chemical properties of ambient bottom water at the seafloor due to their sensitivity to environmental changes (Setoyama *et al*., 2011). The morphogroup analysis has been developed in subsequent studies and applied to interpret various aspects of the palaeoenvironment, such as food supply, oxygenation, substrate and salinity (Tyszka 1994; Bąk, 2004; Szydlo 2004; Reolid*et al.* 2008). Furthermore some authors (e. g. Nagy, 1992; Nagy *et al*., 1995; Kaminski and Gradstein, 2005; Cetean*et al.,* 2011), used theagglutinated morphogroup analyses for a paleoecological interpretation.

The Global Strato-type Section and Point (GSSP) for the P/E boundary was defined at the Dababiya Quarry, 35 kmsouth of Luxor, Egypt (Aubry *et al*., 2002). Many complete Paleocene-Eocene successions have been investigatedin Egypt based on planktic foraminifera or nannofossils such as El Qreiya (Berggren and Ouda, 2003b; Knox *et al*., 2003), Wadi Tarfa and Gabal Um El Ghanayem (Obaidalla, 2006; and Mahfouz, 2008). This study will focus on the agglutinated foraminifera across the Paleocene/Early Eocene boundary from Esna and Thebes formations.

2. Material and Methods

A total of 92 samples collected from the Esna Shale and Thebes formations that represent the upper Paleocene to early Eocene succession at Wasifsection Safaga area, Red Sea, Egypt. One hundred grams from each sample were soaked in 10% of hydrogen peroxide solution for 48 hours, and then boiled at a temperature of 100° C for 2 hours, after complete disintegration the sample was washed in a tin bottle. Approximately 2900 agglutinated foraminiferal specimens have been counted for statically and distribution analysis. All specimens of agglutinated foraminifera were picked from the residue and identified to the rank of genus following the classification of Loeblich and Tappan (1988). The SEM photographs presented in 3 plates were made with the scanning electron microscope in the Electronic Microscopy Laboratory at the Nuclear Materials Authority (NMA), Egypt.

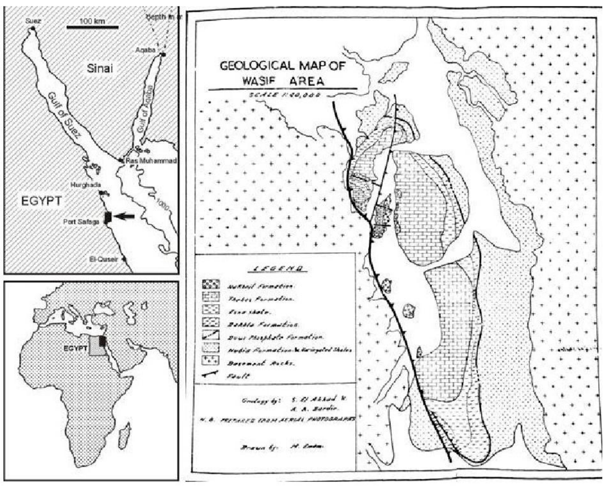


Fig. 1 Location map of Wasif area showing the position of the studied section (after Akkad & Dardir, 1966).

Lithostratigraphy

The upper Paleocene early Eocene succession in Wasif area is consisting of Esna Shale and Thebes formations. The Shale of the Esna Formation lies between two limestone units, the Tarawan at the base and the Thebes at the top. The P/E boundary lies at the lower part of the Esna Shale Formation in the studied section.

The Esna Shale Formation

This formation was introduced by Said (1960), to describe the formation that extending from the top of the Tarawan Chalk to the base of the massive limestones of the Thebes Formation. The authors follows this definition with emendation that provided by Aubry *et al*. (2007) see table (1). On this basis, the Esna Shale Formation at Wasif section attains 46.7 m thick and iscomprised from base to top, El Hanadi, Dababiya Quarry, El-Mahmiya and Abu Had members.

El Hanadi Member

This member was defined by Abdel Razik (1972) to describe the unit that extending from the Tarawan/Esna formational contact to the top of a phosphatic bed in thelower part of the Esna Shale. Aubry *et al*. (2007) emended El Hanadi Member to Unit Esna 1 of Dupuis *et al*. (2003). Lithologically, this member in the studied section attains12m thick and consists of light gray, moderately hard, calcareous shale.

El Dababiya Quarry Member

This member was defined by Aubry *et al*. (2007), as extending from El Hanadi Member to El Mahmiya Member in El Dababiya Quarry, Subsection (DBH). Aubry *et al*. (2007) raised the rank of El Dababiya Quarry Beds of Dupuis *et al*. (2003) to become El Dababiya Quarry Member (DQM). At Wasif section this member is extending from top of El Hanadi Mb. to the base of El Mahmiya Mb. It is attains 2.6m thick. The El Dababiya Quarry Mb. is represented by three upper top beds of Aubry *et al.* (2007), while the lower two beds (1 & 2) of Aubry *et al*., are not recognized. The three beds from baseto topas follows;

Bed 1 attains a (1.2mthick) of cream, colored, phosphatic shale. This bed is equivalent to bed 3 of Aubry *et al*. (2007).

Bed 2attains a (60 cm thick) of yellowish, green shale. This bed is equivalent to bed 4 of Aubry *et al*. (2007).

Bed 3 attains a (80cm thick) ofmarly calcareous, limestone, forming aprominent light gray bed. This bed is equivalent to bed 5 of Aubry *et al*. (2007).

El-Mahmiya Member

El Mahmiya Memberwas introduced by Aubry*et al*. (2007) to describe about 65m thickof dark, clayey shales without marked bedding, and low (<50%) calcium carbonateat GSSP section (Table 1). It's restricted between the Dababiya Quarry Member at the base and Abu Had Member at the top. Furthermore, this member is equivalent to Unit Esna 2 of Dupuis*et al*. (2003). At Wasif section, this member attains a (9m thick) succession of dark, clayey shales, low calcium carbonate.

Abu Had Member

This Member was introduced by Abdel Razik (1972) for the alternating shales and limestone at the transition between the shales of the Esna andthe massive limestones of the Thebes. Dupuis *et al*., (2003) assigned this member to the Esna Shale Formation. Furthermore, they were named this member Unit Esna 3. Aubry *et al*., (2007) named this unit as Abu Had Member because the contact between the massive limestones and the shale facies is clear-cut. At the studied section this member is attains (23 m thick). It consists of light gray, calcareous shalewith thin gypsum veinlets.

Thebes Formation

The Thebes Formation was introduced by Said (1960) to describe about 290m thick of limestone sequence with flint bands that overlies the Esna Shale

Formation at Gabal Gurna, near Luxor, Nile Valley. Akkad & Dardir (1966) considered about 116m thick of limestone with flint that forms bold white cliffs facing is equivalent to the Thebes Formation at Wasif area. The measured Thebes Formation in the studied section attains (18m thick). The basal part of Thebes Formation is formed of yellowish white, soft chalky limestone, rich in foraminiferal fauna, overlain by bed of hard limestones with flint bands or flint nodules.

Table 1 the historical division and lithostratigraphic correlation of the Esna Formation.

<table>
<tr><td>Said (1960) Awad & Ghobrial (1965)</td><td colspan="2">El Naggar (1966)</td><td colspan="2">Abdel Razik (1972)</td><td colspan="2">Dupuis et al. (2003)</td><td colspan="3">Aubry et al.(2007)</td><td colspan="3">This study</td></tr>
<tr><td>Thebes Formation</td><td rowspan="2">Thebes Formation</td><td>Thebes Limestone Mb.</td><td rowspan="2">Thebes Formation</td><td>Serai Limestone Mb.</td><td colspan="2">Thebes Limestone Mb.</td><td colspan="3">Thebes Limestone Formation</td><td colspan="3">Thebes Formation</td></tr>
<tr><td rowspan="4">Esna Shale Formation</td><td>Thebes calcareous Shale Mb.</td><td>Abu Had Mb.</td><td rowspan="4">Esna Shale</td><td>Esna 3</td><td rowspan="4">Esna Shale</td><td colspan="2">Abu Had Mb.</td><td rowspan="4">Esna Shale</td><td colspan="2">Abu Had</td></tr>
<tr><td rowspan="4">Owaina Formation</td><td rowspan="3">Upper Owaina Shale Mb.</td><td rowspan="3">Esna Shale</td><td rowspan="2">El Shaghab Mb.</td><td>Esna 2</td><td colspan="2">El Mahmiya Mb.
....
El Quda bed ....</td><td colspan="2">El Mahmiya Mb.</td></tr>
<tr><td>Dababiya Quarry Bed</td><td>Dababiya Quarry Mb.</td><td>5
4
3
2
1</td><td>Dababiya Quarry Mb.</td><td>3
2
1</td></tr>
<tr><td>El Hanadi Mb.</td><td>Esna 1</td><td colspan="2">El Hanadi Mb.</td><td colspan="2">El Hanadi Mb.</td></tr>
<tr><td>Tarawan Chalk Awad & Ghobrial (1965)</td><td>Middle Owaina Chalk Mb.</td><td colspan="2">Tarawan Chalk</td><td colspan="2">Tarawan Chalk</td><td colspan="3">Tarawan Chalk Formation</td><td colspan="3">Not studied</td></tr>
</table>

Table 2 Comparison between the planktic foraminiferal biozones with some standard biozones

Age	Datum events	Berggren *et al.* (1995)		Berggren & Ouda (2003a, b)		Wade *et al.* (2011)		This study	
Ypresian	*M. subbotinae* *M. aragonensis*	P7	*M. aragonensis/* *M. formosa*	P7		E5	*M. aragonensis/* *M. subbotinae*	E5	*M. aragonensis/* *M. subbotinae*
	M. formosa	P6b	*M. formosa/* *M. lensiformis/* *M. aragonensis*	P6	P6b	E4	*M. formosa*	E4	*M. formosa*
	M. velascoensis	P6a	*M. velascoensis* *M. formosa* *M. lensiformis*		P6a	E3	*M. marginodentata*	E3	*M. marginodentata*
	P. wilcoxensis				P5c	E2	*P. wilcoxensis/* *M. velascoensis*	E2	*P. wilcoxensis/* *M. velascoensis*
	A. sibaiyaensis *A africana*	P5	*M. velascoensis*	P5	P5b	E1	*A. sibaiyaensis*	E1	*A. sibaiyaensis* *A. africana*
Thanetian	*G. pseudomenardii*				P5a	P5	*M. velascoensis*	P5	*M. velascoensis*

A. = Acarinina G. = Globanomalina M. = Morozovella P. = Pseudohastigerina

Benthonic Foraminiferal Biostratigraphy

The identified benthic foraminifera from late Paleocene/Early Eocene at Wasif section are allowing local benthic foraminiferal biostratigraphic zonation. The benthic fauna is exhibits affinity close with the Midway-type fauna. Three zones have beenrecognized herein from oldest to youngest as follows;

1- ***Loxostomoides applinae* Zone:**

Definition: interval from the FO of *Loxostomoides applinae*to FO of *Valvulineria scrobiculata*.

Age and correlation: The *Loxostomoides applinae* Zone is late Paleocene age and its correlates with the *Globanomalina pseudomenardii* (P4c) Zone of planktic foraminiferal. It's corresponds to the lower part of the Esna Shale Formation (El Hanadi Member) at Wasif section.

The *Loxostomoides applinae* Zone is characterized by the presence of *Loxostomoides applinae*, *Marginulina carri* and *Marginulinopsistuberculata*and others as calcareous benthic foraminifera. The most important of agglutinated foraminiferal species at this zone is *Bathysiphon arenaceous*, *B. alexanderi*, *Spiroplectamina dentata, S. esnaensis, Trochamina albertensis,* and *Vulvulina colei* and others (Fig. 5).

Remarks: The *Loxostomoides applinae* Zone is well known as a local benthic biozones (late Paleocene) in Egypt. This zone is equivalent to the identical one at the North Central Sinai (Ismail 2002), and Farafra-Dakhla stretch (Aly, 2007).

Table 3 Comparison between the local of benthic foraminiferal biozones in Egypt.

Age	Le Roy (1953)	Hewaidy (1987)	El Feel (2001)	Ismail (2002)	El Dawy and Hewaidy (2002)	Aly (2007)	This study
Early Eocene	*Eponides lotus*	*Marginulina wetherellii*	*Marginulina longicostata*	*Marginulina wetherellii*	*Bulimina farafraensis /B. esnaensis*	*Marginulina wetherellii*	*Eponides lotus* *Valvulineria scrobiculata*
Late Paleocene	*Bulimina farafraensis*	*Gavinella danica*	*Marginulinopsis tuberculata*	*Loxostomoides applinae*	*Bulimina quadrata /B. midwayensis*	*Loxostomoides applinae*	*Loxostomoides applinae*

2- ***Valvulineria scrobiculata*** **Assemblage Zone**:

Definition: Interval of the range of nominates taxa between the LO of *Loxostomoides applinae* andthe FO of *Eponides lotus*.

Age and correlation: The *Valvulineria scrobiculata*assemblage Zone spans the Lower Eocene age and correlated with the Ypresian *Acarinina sibaiyaensis* (E1), *Pseudohastigerina wilcoxensis/Morozovella velascoensis* (E2), *M. marginodentata* (E3), *M. formosa* (E4), and the basal part of *M. aragonensis*/*M. subbotinae* (E5) zones (samples 23–48).

This zone is equates with the Esna Formation portion of the Dababiya Quarry Member, Mahmiya and basal part of the Abu Hadmembers. The *Valvulineria scrobiculata* Assemblage Zone is distinguished bythe presence of *Bulimina* spp., *Anomalinoides aegyptiacus, A. zitteli, Oridorsalis plummerae, Gaudryina elegantissm*a, *G. soldadoensis*, *Ammobaculites coprolithiformis*, *Marssonella identa*, *Pseudoclavulina globulifera*in addition to the nominate taxa and others.

Remarks: This zone can be correlated with the *Anomalinoides aegyptiaca/Valvulineria scrobiculata*assemblage of Ernst *et al.* (2006), from the Dababiya Strato-type section, near Luxor (GSSP). Also, it isequivalent to the lower part of *Marginulina wetherellii* Zone of Hewaidy (1987), Ismail (2002), and Aly (2007).

3- ***Eponides lotus*** **Zone**:

Definition: Interval from the LO of the *Valvulineria scrobiculata*to LO of *Eponides lotus.*

Age and correlation: The *Eponides lotus* interval zone is assigned to the Lower Eocene age and correlates withthe *M. aragonensis/M. subbotinae* (E5) planktonic foraminiferal zone (samples 49-92). This zone is covered most part of Abu Had Memberand the measured part of the Thebes Formation.

The *Eponides lotus* interval zone is associated with *Anomalinoides zitteli, A. umbonifera, Bulimina esnaensis, Dorothia pupa, Textularia schwageri, Pseudoclavulina clavata, Gaudryina rugosa*, *Haplophragmoides* spp. and *Trochammina* spp.

Remarks: The faunal association of this zone occurs in the upper part of Esna Shale and Thebes formations. Can be correlated this zone with the *Eponides lotus* Zone of Maqfi section, Farafra Oasis (Le Roy, 1953) and the upper part of *Marginulina Wetherellii* Zone of the Farafra-Dakhla stretch (Aly 2007) (Table 3).

Morphogroups

The main ideas behind the morphogroup analysis are that species with different test shapes have different preferred life habitats, which can be related to feeding strategies, and that changes in the relative abundance of morphogroups in assemblages reflect environmental changes through time (Corliss, 1985; Jones and Charnock, 1985; Setoyama *et al*., 2011). The paleoecologic parameters which are used in the present study includes: (1) test morphology, comprising general outline, number of chambers, chamber arrangement, architecture, and size of test; (2) life habitat, characterized as deep infaunal, shallow infaunal or epifaunal; and (3) supposed feeding strategies, characterized as suspension feeders, deposit feeders (Nagy *et al*., 2009).

Characteristic features of the agglutinated assemblages in the investigated area include: a) occurrence in the fine grained interval of the turbidity sequences; b) agglutinated taxa are dominant; d) cosmopolitan distribution; e) coarse grained and medium sized tests are dominant. Three types of agglutinated foraminiferal assemblages (Fig. 6) were recognized:

A) Assemblages with tubularagglutinated foraminifera.

The tubular assemblagezone is recorded in the lower part of the Esna Shale Formation in the studied section, (El Hanadi Member). This part is consists of light gray, moderately hard, calcareous shale.

This interval is highly rich by planktic and benthic foraminifera. The planktic/benthic ratio (P/B %) is high (~85%). The main planktic foraminiferal contents are *Subbotina*, *Acarinina* and *Morozovella*. The calcareous/arenaceous ratio (C/A) is also, high, (~83%). The most common calcareous benthic taxa are observed in this interval are: *Anomalinids*, *buliminids*, *Cibicidoides*, *lenticulinids*, *spiroplectamminids* and *valvalabaminids*. Furthermore, *Loxostomoides applinae, Oridorsalis plummerae,* and *Stilostomella midwayensis*…etc. The faunal content found decrease towards the Paleocene/Eocene boundary.

The tubular assemblage zone is dominated by tubular formsand contains on three types of morphogroups; tubular 64.5 %,elongate keeled 20% and elongate subcylindrical15.5%.The dominate forms belongs to morphogroup M1 in the classification of Kaminski and Gradstein (2005). The epifaunal agglutinated morphogroups are consists mainly of tubular (e.g. *Bathysiphonarenaceous*, *Bathysiphon brosgei* and *Nothia* species) and elongated keeled (e.g. *Spiroplectammina dentate*, *Spiroplectammina esnaensis* and *Spiroplectinella knebeli*). Infaunal agglutinated morphogroups are dominated by elongate subcylindrical (e.g. *Textularia farafraensis* and *Textularia nilotica*) Fig. 2. The most common agglutinated morphogroups in this interval are the epifaunal tubular taxa with a suspension feeding strategy. According to Jones and Charnock (1985), the significant presence of this morphogroup suggests to lower bathyal to abyssal deep-water settings with low organic flux.

B) Assemblages with elongated subcylindrical agglutinated foraminifera.

The elongate subcylindrical zone is recorded in the middle part of the Esna Shale Formation (El Mahmiya Member). The upper part of the Esna Shale Formation is represented by (El Dababiya Quarry, El Mahmiya and Abu Had members). This part is consists of light to dark brown, moderately hard, calcareous shale intercalated by marl in the Abu Had Member.

The lower part of this interval is represents by the base of DQM. This part is characterized by phosphatic shale layer with glauconitic grains (1.2 m) that is distinguishes the lowermost part of the Eocene and marks the onset of the Initial Eocene Thermal Maximum (IETM) interval that characterized the P/E boundary. The foraminiferal faunas had been became absent through this interval.

The middle part of this interval includes the top part of DQM and El Mahmiya Members. This part is distinguishes by calcareous shale and calcarenitic marl beds. This interval is witnessed by the recovery and repopulation (Survivors) of most planktic and benthic foraminiferal assemblages.

The top part of this interval is represents by the Abu Had Member. This interval is consist of consists of light gray, calcareous shalewith thin gypsum veinlets. This interval saw a great rebound of *Gaudryina*, *Spiroplectammina*, and *Pseudoclavulina*,

This zone contains on three types of morphogroups; elongate subcylindrical 66.6%, elongate keeled 20.4% and tubular 13%. The dominate forms belongs to morphogroup M4b in the classification of Kaminski and Gradstein (2005); it's includes deep infaunal elongate subcylindrical taxa with active deposit feeding strategy. The assemblage is characterized by opportunistic forms as: *Textularia nilotica*, *Tex. farafraensis*, *Pseudoclavulina amorpha*, *Ps. farafraensis*, *Ps. clavata*, *Ps. globulifera*, *Ps. maqfiensis*, *Clavulinoides aspera*, *Cl. trilaterus*, *Marssonella oxycona*, Dorothia *bulletta*, Marssonella *indeta*, *Gaudryina aissana*, *Ga. africana*, *Ga.*

elegantissma, *Ga. limbata*, *Ga. pyramidata*, *Ga. rugosa*, *Ga. soldadoensis* and *Tritaxia barakai*. It's includes epifaunal tubular taxa with active deposit feeding strategy, the size of the fauna is large. According to Jones and Charnock (1985), the significant presence of this morphogroup suggests Inner shelf to upper bathyal with increased organic matter.

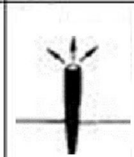
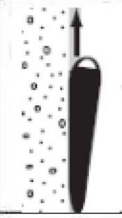
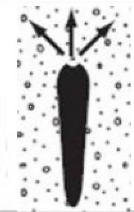
Group	Test form				
	Tubular WS1	Elongate keeled WS2	Rounded planispiral WS3	Elongate subcylindrical WS4	Elongate tapered WS5
Morphogroup					
Main genera	*Bathysiphon* *Nothia*	*Spiroplectamina* *Spiroplectinella*	*Haplophragmoides*	*Textularia* *Vulvulina* *Pseudoclavulina* *Clavulinoides* *Marssonella* *Dorothia* *Goudryina* *Verneuilina*	*Ammobaculites*
Life position	Erect epifauna	Surficial epifauna	Surficial epifauna and/or shallow infauna	Deep infauna	Deep infauna
Feeding habitat	Suspension feeding	Active deposit feeding	Active deposit feeding	Active deposit feeding	Active deposit feeding
environment	Tranquil bathyal and abyssal with low organic flux	Shelf to marginal marine	Inner shelf to upper bathyal	Inner shelf to upper bathyal with increased organic matter flux	Inner shelf to upper bathyal with increased organic matter flux
Similar group in Setoyama *et al.*, 2011	M1	M2c	M4a	M4b	M4b
	Kalamopsis *Psammosiphonella* *Rhizammina*	*Plectoeratidus*	*Buzasina* *Evolutinella* *Popovia* *Reticulophragmoides*	*Gerochammina* *Hormosina* *Karrerulina* *Praedorothia* *Protomarssonella*	*Bicazammina* *Eobigenerina* *Rashnovammina* *Reophax* *Subreophax*

Fig. 2 Foraminiferal morphogroups distinguished Wasif assemblages, with microhabitats and feeding strategies.

C) Assemblages with rounded planispiral agglutinated foraminifera

The rounded planispiral zone is recorded at the measured part of the Thebes formationsin the studied section and dominated by rounded planispiral forms. This zone is contains on two types of morphogroups; rounded planispiral 55% and elongate tapered 45%. The dominate forms belongs to morphogroup M4b in the classification of Kaminski and Gradstein (2005).

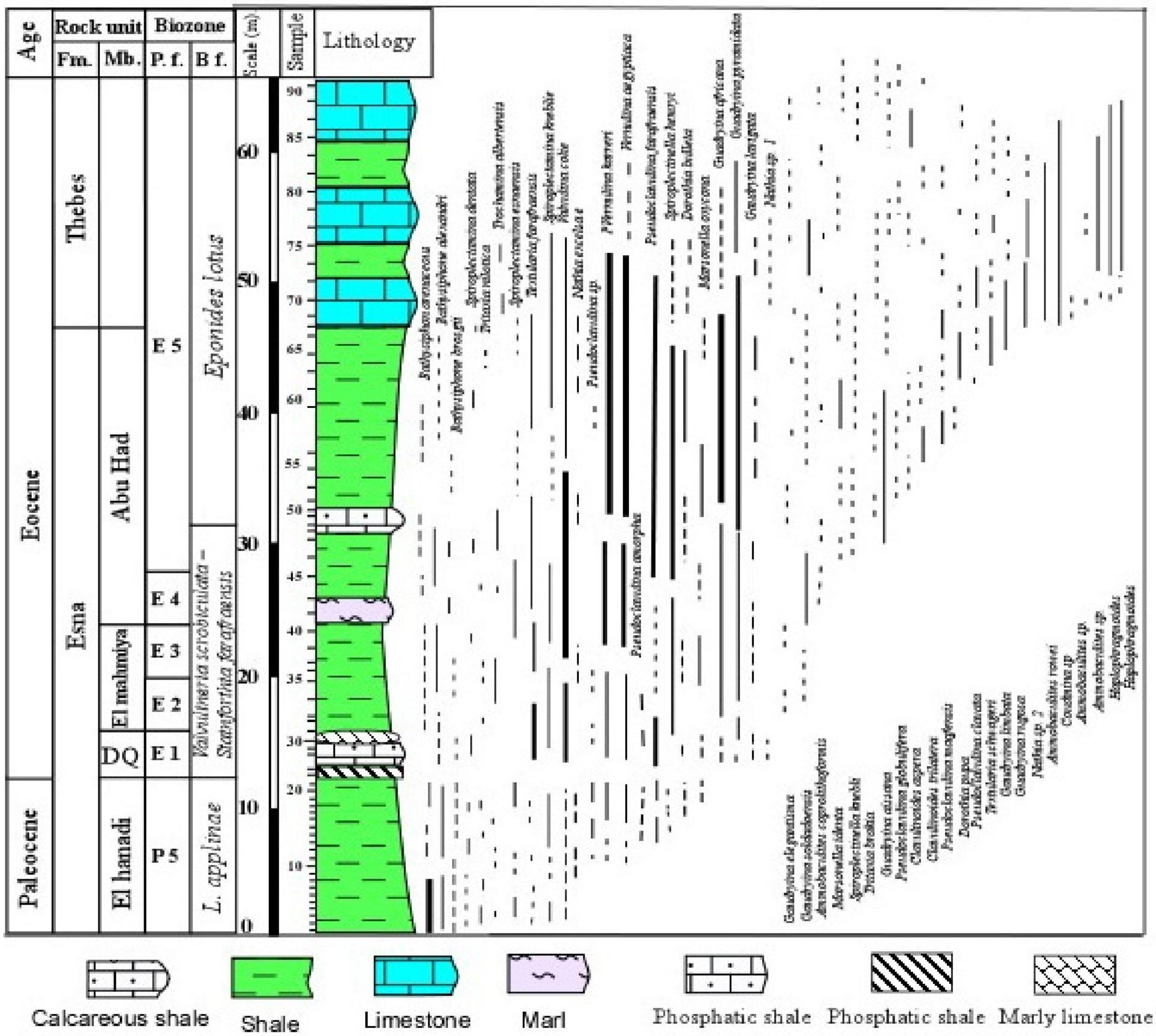


Fig. 3 Stratigraphic distribution chart of agglutinated foraminiferal species around the P/E boundary at Wasif section.

It's including surficial epifaunal and/or shallow infauna with active deposit feeding strategy. This zone is distinguished by low diversity, high dominance and the rare occurrence or absence of elongate keeled, elongate subcylindrical that indicates on shallow water conditions is similar to an inner to middle shelf environments (Backman *et al*. 2006). The assemblage is characterized by opportunistic forms as: *Ammobaculites coprolithiformis*, *Ammobaculites rowei* and *Ammobaculites sp.* According to Jonesand Charnock (1985), the significant presence of this morphogroup suggests Inner shelf.

Systematic Paleontology

Species list, presented below included only agglutinated taxa determinate from the Paleocene/Early Eocene deposits at the Wasif section. The classification of Loeblich and Tappan (1988) has been used for the agglutinated foraminiferal genera. The following is a systematic discussion for the identified species:

Order: Foraminifera Eichwald, 1830

Suborder: Textulariina Delage and Herouard, 1896

Superfamily: Astrorhizacea Brady, 1881

Family: Bathysiphonidae Avnimelech, 1950

Genus: *Bathysiphon* Sars, 1872

Bathysiphonalexanderi Cushman, 1933

Plate 2, figure 1

Bathysiphonalexanderi Cushman 1933, p. 49, pl. 5, fig. 1, Cushman 1946, p. 14, pl. 1, fig. 5.

Remarks: Chambers nearly uniform in diameters

Bathysiphon arenaceous Cushman, 1927

Plate 2, figure 2

Bathysiphon arenaceous Cushman, 1927, p.129, pl. 1, fig. 2 (8, 16); Anan and Hewaidy, 1986, p. 18, pl. 1, fig. 1 and Hewaidy and Strougo, 2001, pl. 1, fig. 1, Hewaidy et. al 2014, p. 4, pl. 1, fig. 1.

Remarks: it's surface rougher than *B. alexanderi*.

Bathysiphon brosgei Tappan, 1962

Plate 2, figure 3

Bathysiphon brosgei Tappan 1962, p. 202, pl. 65, figs. 1-5 and Sliter 1968, p. 39, pl. 1, fig. 1.

Remarks: non-septate test, irregular bent.

Genus *Nothia* Pflaumann, 1964

Nothia excelsa (Grzybowski, 1898)

Plate 2, figure 4

Dendrophyra excelsa Grzybowski, 1898, p272, pl.10, figs. 1-4.

Nothia excelsa (Grzybowski) - Kaminski *et al.*, 1993, p.245, pl. 1, figs 2-6,15 a-b, Waśkowska-Oliwa, 2005, p. 24, pl. 1, fig. 9.

Remarks: Its sides irregular, wall agglutinated, medium to coarse grain size.

*Nothia sp.*1

Plate 2, figure 5

Remarks: This species differs from *N. excelsa* in itstest not branched, irregular sides, wall medium to coarse grain size.

*Nothia sp.*2

Plate 2, figure 6

Remarks: Wall agglutinated, medium to coarse grain size.

Genus *Ammobaculites* Cushman, 1910

Ammobaculites coprolithiformis (Schwager, 1868)

Plate 2, figure 7

Hapolphragmium coprolithiformis Schwager, 1868, p. 654, pl. 34, fig. 3.

Remarks:

Ammobaculites rowei Banner, 1953

Plate 2, figure 8

Ammobaculites rowei Banner, 1953, p. 180, pl. 7, fig. 6 and Orabi, 2000, p.386, pl.1, fig. 29.

Remarks: its wall thick and rugose.

Ammobaculites sp.

Plate 2, figure 9

Remarks: it differs from other *Ammobaculites*species in its test curved.

Genus: *Cribrostomoides* Cushman, 1910

Cribrostomoides cretacea Cushman and Goodkoff, 1944

Plate 2, figure 10

Cribrostomoides cretacea Cushman and Goodkoff, 1944, p. 54, pl. 9, fig.4 and Trujillo, p. 306, pl. 43, figs. 7a-8c and Hewaidy *et al*. 2014, p. 11, pl. 2, fig. 3.

Remarks: test compressed planispiral, periphery lobulated.

Genus: *Trochammina* Parker and Jones, 1859

Trochammina albertensis Wickenden, 1932

Plate 2, figure 11

Trochammina albertensis Wickenden, 1932, p.90, pl. 1, figs. 3a, b and Abd El Hameed, 1973, p.104, pl. 5, figs. 3a, b.

Remarks: Test circular to rectangular, flat, periphery subacute, often lobulated; wall finely arenaceous, surface smooth, aperture not visible.

Genus: *Spiroplectammina* Cushman, 1927

Spiroplectammina dentata (Alth, 1850)

Plate 2, figure 12

Textularia dentata Alth, 1850, p.262, pl.3, fig.13.

Spiroplectammina dentate (Alth, 1850) - Cushman 1946, p. 27, pl.5, fig. 11; Said and Kenawy 1956, p. 121, pl.1, fig. 9; Aubert and Berggren 1976, p. 408, pl. 1, fig. 5 and Ismail 1989, p. 123, pl. 1, fig. 7.

Spiroplectinella dentata (Alth, 1850) - El Dawy, 2001, P.13, Pl.1, Fig.3 and Hewaidy *et al*. 2014, p. 18, pl. 3, fig. 18.

Remarks: chambers rapidly increasing in breadth as added; sutures straight to slightly curved.

Spiroplectammina desertorum (Le Roy, 1953)

Plate 2, figure 13

Spiroplectammina desertorum Le Roy, 1953 p. 50, pl.1, figs. 19, 20.

Bolivinopsis desertorum (Le Roy, 1953) - Abd El Salam, 1965, p. 106, pl. 5, fig. 8.

Remarks: Test tapering from pointed initial end to greatest width, chambers slowly increasing in heights as added.

Genus: *Spiroplectinella* Kisel Man, 1972

Spiroplectinella esnaensis (Le Roy, 1953)

Plate 2, figure 14

Spiroplectammina esnaensis Le Roy, 1953, p. 50, pl. 1, figs. 11, 12; Aubret and Berggren, 1976, p. 409, pl. 1, fig. 6 and Shahin, 1990, p.498, pl.1, fig.10.

Spiroplectinella esnaensis (Le Roy, 1953) - Spijer, 1994, p.147, pl.1x, fig.1, Aly, *et al*., 2011, p. 83, pl. 1, fig. 8 and Hewaidy *et al*., 2014, p. 18, pl. 3, fig. 18.

Remarks: Test tapering with moderately thick at central portion, chambers inflated, periphery acute; sutures slightly curved.

Spiroplectinella henryi (Le Roy, 1953)

Plate 2, figure 15

Spiroplectammina henryi Le Roy, 1953, p. 50, pl. 2, figs. 14, 15; Said and Kenawy, 1956, p. 121, pl. 1, fig. 11 and Orabi, 1988, p. 162, pl. 1, fig. 16.

Spiroplectammina knebeli (Le Roy) - Aref and Youssef, 1996, p. 572, pl. 5, fig. 4, Aly, *et al*. 2011, p.

84, pl. 1, fig. 9and Hewaidy *et al*. 2014, p. 20, pl. 3, fig. 20.

Remarks: Test moderately thickened, sharply rounded, chambers inflated, sutures curved, depressed.

Spiroplectinella knebeli (Le Roy, 1953)

Plate 2, figure 16

Spiroplectammina knebeli Le Roy, 1953, p. 51, pl.2, figs. 10, 11; Said and Kenawy, 1956, p.121, pl.1, fig. 10; Waer, 1965, p. 140, pl.7, fig.27; Shahin, 1988, p.69, pl.14, fig.7.

Spiroplectammina henryi Le Roy, 1953 - Aref and Youssef, 1996, p.572, pl.5, fig.5.

Spiroplectinella knebeli (Le Roy) - El Dawy, 2001, p.20, text -Fig.3.

Remarks: Test quadrate, thicker to-wards the apertural end.

Spiroplectinella knebeli longa (Said and Kenawy, 1956)

Plate 2, figure 17

Spiroplectammina knebeli longa Said and Kenawy, 1956, p. 122, pl. 1, fig. 12.

Spiroplectinella longa (Said and Kenawy, 1956)- Hewaidy *et al*, 2014, p. 20, pl. 3, fig. 22.

Remarks: this species differs from *S. knebeli* in its having a longer test in relation to its width and the last formed chamber having a less flaring.

Genus: *Vulvulina* D' Orbigny, 1826

Vulvulina colei Cushman, 1932

Plate 2, figures 18, 19

Vulvulina colei Cushman, 1932, p. 84, pl. 10, figs. 21, 22; Nakkady, 1951, p. 400, pl. 1, fig. 6; Le Roy, 1953, p. 54, pl. 8, fig. 15; Anan and Sharaby, 1988, p. 200, pl. 1, fig. 7; Ismail, 1989, p. 124, pl. 1, fig. 9; Shahin, 1990, p. 498, fig. 6 (13) and Galal, 1995, p. 59, pl. 7, fig. 12 and Hewaidy, *et al*., 2014, p. 21, pl. 4, fig. 2.

Remarks: Test elongate, early chambers planispiral, then biserial, later long, uniserial, wall finely arenaceous, smoothly finished.

Genus: *Gaudryina* D' Orbigny, 1839

Gaudryina africana Le Roy, 1953

Plate 2, figure 20

Gaudryina soldadoensis (Cushman and Renz, 1946) - Aref and Youssef, 1996, p.572, pl.5, fig.19

Gaudryina africana Le Roy, 1953, p.30, pl. 1, figs. 7, 8; Spijer, 1994, p. 147, pl. ix, fig. 3.

Remarks: Triserial portion compressed, biserial portion consists of 3, 4 pairs of inflated chambers.

Gaudryina aissana Ten Dam and Sigal, 1950

Plate2, figure 21

Gaudryina aissana Ten Dam and Sigal, 1950, p.31, pl.2, fig.2; Aubert and Berggren, 1976, p. 409, pl.1, fig. 10; Luger, 1985, P.78, Pl.3, Figs.10, 11 and Shahin, 1988, P. 499, Fig 9 (22-26).

Remarks: Triserial portion represented about ⅕ of the whole of the test, biserial part is flattened**.**

Gaudryina elegantissma Said and Kenawy, 1956

Plate 2, figure 22

Gaudryina elegantissma Said and Kenawy, 1956, p. 123, pl. 1, fig. 21 and Hewaidy *et al*., 2014, p.21, pl. 4, fig. 4.

Remarks: Triserial part is very short, biserial portion flattened

Gaudryina leavigata Franke, 1914

Plate 3, figure 1

Gaudryina leavigata Franke, 1914, p. 431, pl. 27, figs. 1, 2; Cushman, 1946, p. 33, pl. 8, fig. 4; Nakkady, 1959, p. 457, pl. 1, fig. 5.

Remarks: This species differs from *G. aissana* in its triserial portion represented about ⅓ or slightly more of the whole of the test.

Gaudryina limbata Said and Kenawy, 1956

Plate 3, figure 2

Gaudryina limbata Said and Kenawy, 1956, p. 123, pl. 1, fig. 23, Hewaidy and El Ashwah, 1993, pl. 1, fig. 12 and Hewaidy *et al*., 2014, p. 21, pl. 4, fig. 5.

Remarks: This species differs from *Gaudryina pyramidata* in being more elongate and in having more chambers, sharper edges.

Gaudryina pyramidata Cushman, 1926

Plate 3, figures 3

Gaudryina pyramidata Cushman, 1926, p. 587, pl. 16, fig. 8; Le Roy, 1953, p. 31, pl. 1, fig. 17, 18; Sliter, 1968, fp. 48, pl. 3, fig. 9; Hewaidy and El-Ashwah, 1993, p. 269, pl. 1, fig. 14; El Shaarawy *et al*., 1995a, p. 5, pl. 1, fig. 11 and Ayyad *et al*., 1996a, fig. 5 (i).

Remarks: chambers slightly inflated in the biserial portion.

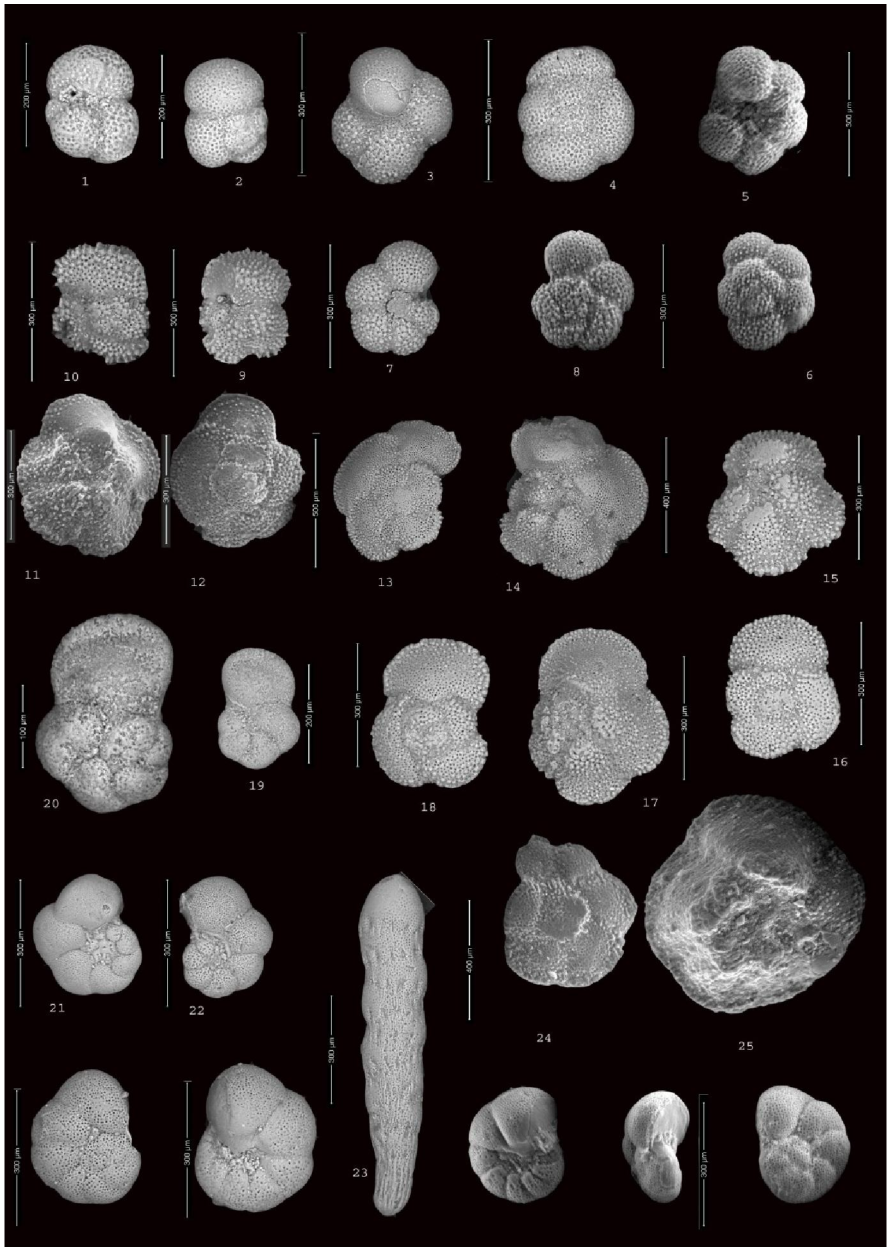


Plate 1

1-2 *Subbotina triloculinoides* (Plummer, 1926). samplen. 5. 3-4 *Acarinina soldadoensis* (Brönnimann, 1952), sample no.15. 5-6 *Acarinina africana* (El Naggar), sample no. 24. 7-8 *Acarinina sibaiyaensis* (El Naggar), sample no. 24. 9-10 *Morozovella aequa* (Cushman and Renz, 1942), sample 24. 11-12 *Morozovella aragonensis* (NUTTALL). *Morozovella formosa* (Bolli), sample no. 43. 15-16 *Morozovella marginodentata* (Subbotina 1953), sample 38.17-18 *Morozovella subbotinae* (Morozova, 1939), sample 55. 19-20 *Globanomalina pseudomenardii.*21-22 *Pseudohastigerina wilcoxensis* (Cushman and Ponton), sample no33. 23 *Loxostomoides applinae* (Plummer), sample no. 6. 24-25 *Valvulineria scrobiculata* (Schwager), sample no. 22. 26-27 *Eponides lotus* (Schwager), sample no. 68.

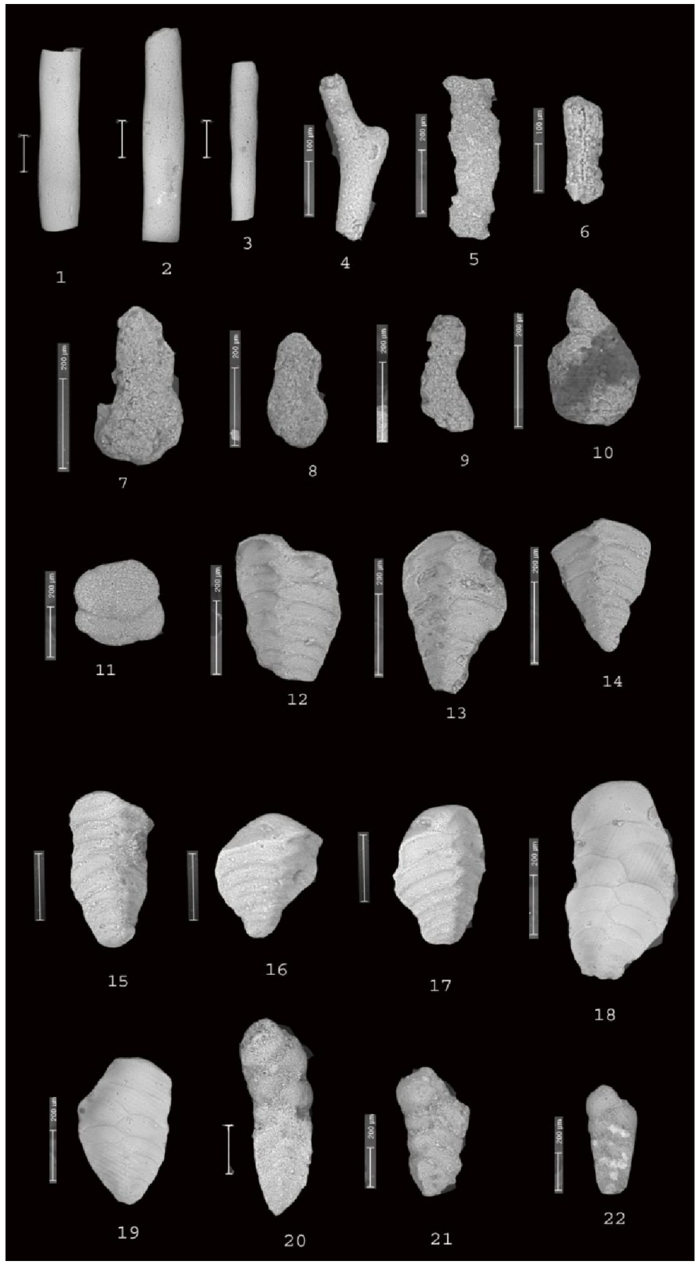


Plate 2

1. *Bathysiphon alexanderi* Cushman, 1933 (sample 28, 75x). 2. *Bathysiphon arenaceous* Cushman, 1927 (Sample 15, 75x). 3. *Bathysiphon brosgei* Tappan, 1962 (sample 15, 75x). 4. *Nothia excelsa* (Grzybowski, 1898) (sample 7, 221x).5. *Nothia sp.*1 (sample 15, 130x). 6. *Nothia* sp. 2, (sample 30, 192x).7. *Ammobaculites coprolithiformis* (Schwager, 1868) (sample 18, 160x). 8. *Ammobaculites rowei* Banner, 1953 (sample 30, 158x). 9. *Ammobaculites sp.* (sample 30, 206x). 10. *Cribrostomoides cretacea* Cushman and Goodkoff, 1944 (sample 18, 165x). 11. *Trochammina albertensis* Wickenden, 1932 (sample 18, 104x). 12. *Spiroplectammina dentata* (Alth, 1850) (sample 3, 150x). 13. *Spiroplectammina desertorum (*Le Roy, 1953) (sample 17, 150x). 14. *Spiroplectinella esnaensis* (Le Roy, 1953) (sample 19, 165x). 15. *Spiroplectinella henryi* (Le Roy, 1953) (sample 8, 135x). 16. *Spiroplectinella knebeli* (Le Roy, 1953) (sample 18, 169x). 17. *Spiroplectinella knebeli longa* (Said and Kenawy, 1956) (sample 20, 135x).18 & 19. *Vulvulina colei Cushman,* 1932 (sample 23, 104 x). 20. *Gaudryina africana* Le Roy, 1953 (sample 14, 100x). 21. *Gaudryina aissana* Ten Dam and Sigal, 1950 (sample 16, 76x). 22. *Gaudryina elegantissma* Said and Kenawy, 1956 (sample 17, 76x).

Gaudryina rugosa D' Orbigny, 1840

Plate 3, figure 4

Gaudryina rugosa D' Orbigny,1840, p. 44, pl. 4, fig. 20; Nakkady, 1952, p.403, pl. 2, fig. 3; Said and Kenawy, 1956, p.124, pl. 1, fig. 25 and El Ashwah, 1993, p.33, pl.7, fig. 12 and Hewaidy 2014, p. 22, pl. 4, fig. 7

Remarks: Test large, elongate; chambers roughly inflated and sub globular.

Gaudryina soldadoensis Cushman and Renz, 1942

Plate 3, figure 5

Gaudryinasoldadoensis Cushmanand Renz, 1942, p. 4, pl. 1, fig. 2, and Hewaidy *et al.*, 2014, p. 24, pl. 4, fig. 8;

Gaudryinasp. Aref and Youssef 1996, p. 572, pl. 5, fig. 19.

Remarks: Test slightly actuate with a slightly concave boarder face.

*Gaudryina zakiaensis*n. sp. Aly

Plate 3, figure 6

Description: test elongate, longer than broad, early chambers triserial, later biserial, chambers distinct, slightly inflated in triserial portion, flattened, globular in biserial portion, periphery acute, sutures distinct, curved, slightly depressed at the triserial portion, straight, depressed in the biserial portion, wall coarsely arenaceous with smooth surface, aperture a low opining in a semicircular of the inner margin of the last formed chamber.

Remarks: This species differs from others *Gaudryina spp.* in its triserial portion is represent about ⅔or slightly more of the whole of test and the biserial portion contains on two inflated globular chambers.

Genus: *Verneuilina* D' Orbigny, 1840

Verneuilina karreri Said and Kenawy, 1956

Plate 3, figure 7

Verneuilina karreri Said and Kenawy, 1956, p. 122, pl. 1, fig. 7; Shahin, 1988, p. 70, pl., fig. 15 and Hewaidy and El Ashwah, 1993, p. 269, pl. 1, fig. 24.

Remarks: Test slightly elongate, tapering, sides flattened, chambers indistinct, regularly, rapidly increasing in size as added.

Verneuilina aegyptiaca Saidand Kenawy, 1956

Plate3, figure 8

Verneuilina aegyptiaca Said and Kenawy, 1956, P. 122, Pl. 1, Fig. 16; Shahin, 1988, P. 70, Pl. 15, Fig. 8; El Ashwah, 1993, P. 34, Pl. 7, Fig. 14 and Galal, 1995, P. 60, Pl. 7, Fig. 17.

Remarks: This species is differs from others *Verneuilina*species in its test more inflated, increasing rapidly in size as added with more rounded angles.

Genus: *Dorothia* Plummer, 1931

Dorothia bulletta (Carsey, 1926)

Plate 3, figure 9

Gaudryina bulletta Carsey, 1926, p. 28, pl. 4, fig. 4.

Dorothia bulletta (Carsey) - Cushman, 1946, p. 46, pl. 12, figs. 21, 26 and Le Roy, 1953, p. 27, pl. 2, figs. 7, 8 and Hewaidy *et al*. 2014, p. 24, pl. 4, fig. 11.

Remarks: test elongate, slightly twisted, subovate in apertural view.

Dorothia pupa (Reuss, 1860)

Plate 3, figure 10

Textulariapupa Reuss, 1860, P. 232, Pl. 13, Fig. 4

Dorthia pupa (Reuss) - Le Roy, 1953, P. 28, Pl. 1, Figs. 14, 15; Said and Kenawy, 1956, P. 128, Pl. 1, Fig. 53; Hewaidy and El Ashwah, 1993, Pl. 11, Fig. 11 and El Shaarawy *et al.*, 1995a, P. 9, Pl. 2, Fig. 5.

Remarks: Its differs from the *Dorothia bulletta* in having a smaller early portion, nearly present about ⅛ of the test, later portion is longer, sutures wider than in *bulletta*, chambers more than 8 in last stage.

Genus: *Marssonella* Cushman, 1933

Marssonella indentata (Cushman and Jarvis, 1928)

Plate 3, figures 11

Gaudryina indentata Cushman and Jarvis, 1928, p. 92, pl.13, fig. 7.

Marssonellaindentata (Cushman and Jarvis), Cushman, 1946, p. 44, pl. 12, figs. 6, 7 and Said and Kenewy, 1956, p.127, pl. 1, fig. 47.

Remarks: This species is characterized by having a small number of distinct, inflated chambers.

Marssonella oxycona (Reuss, 1860)

Plate 3, figure 12

Gaudryina oxycona Reuss, 1860, p. 229, pl. 12, fig. 3.

Marssonella oxycona (Reuss) - Cushman, 1933, p. 36, pl. 4, fig. 13; Said and Kenawy, 1956, p. 127, pl. 1, fig. 48 and El Saadany, 1995, p. 106, pl.3, fig.2 and Hewaidy *et al.*, 2014, p. 25, pl. 4, fig. 13.

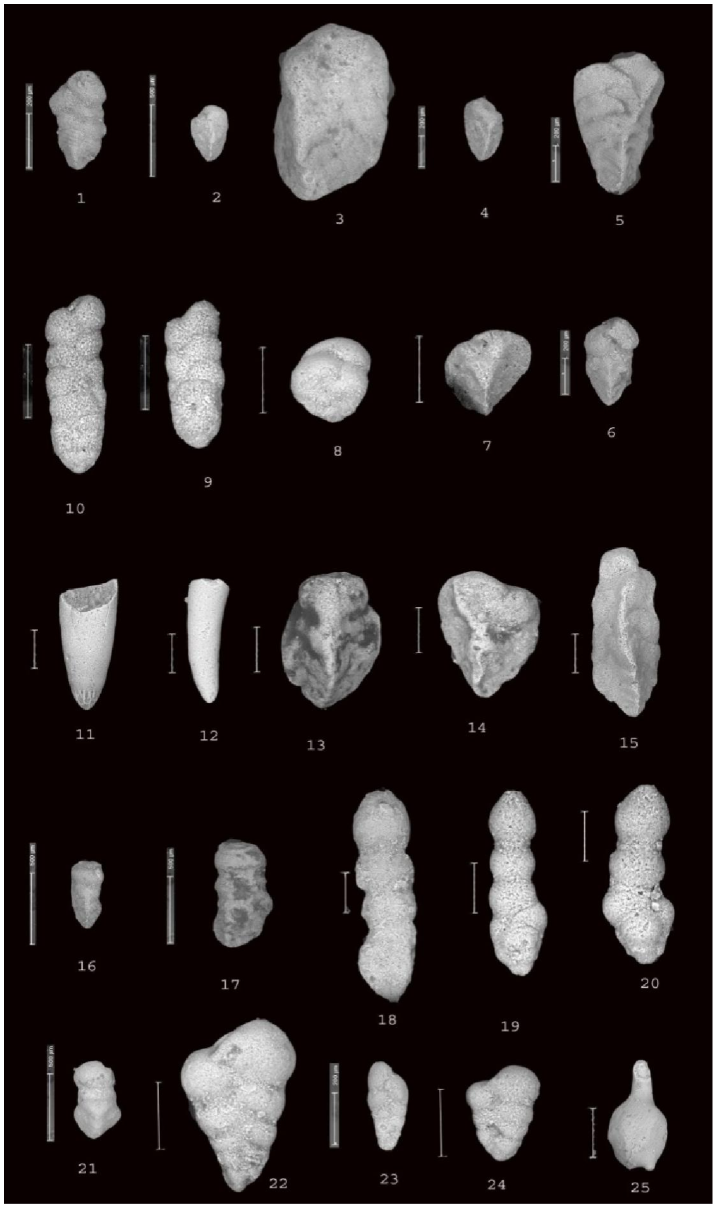


Plate 3

1. *Gaudryina leavigata* Franke, 1914 (sample 29, 71x).2. *Gaudryina limbata* Said and Kenawy, 1956 (sample 27, 71x). 3. *Gaudryina pyramidata* Cushman, 1926 (sample 25, 89x). 4. *Gaudryina rugosa* D' Orbigny, 1840 (sample 25, 71x). 5. *Gaudryina soldadoensis* Cushman and Renz, 1942 (sample 28, 89x). 6. *Gaudryina zakiaensis*n. sp. Aly (sample 15, 89x). 7. *Verneuilina karreri* Said and Kenawy, 1956 (sample 5, 164x). 8. *Verneuilina aegyptiaca* Said and Kenawy, 1956 (sample 21, 164x). 9. *Dorothia bulletta* (Carsey, 1926) (sample 24, 181x). 10. *Dorothia pupa* (Reuss, 1860) (sample 22, 181x). 11. *Marssonella indentata* (Cushman and Jarvis, 1928) (sample 28, 129x). 12. *Marssonella oxycona* (Reuss, 1860) (sample 18, 190x). 13. *Tritaxia barakai* Said and Kenawy, 1956 (sample 20, 111x). 14. *Clavulinoides aspera* (Cushman, 1926) (sample 16, 111x). 15. *Clavulinoides trilaterus* (Cushman, 1926) (sample 20, 129x). 16. *Pseudoclavulina amorpha* (Cushman, 1926) (sample 5, 71x). 17. *Pseudoclavulina clavata* (Cushman, 1937) (sample 21, 66x). 18. *Pseudoclavulina farafraensis* Le Roy, 1953 (sample 18, 100x). 19. *Pseudoclavulina globulifera* (Ten Dam and Sigal, 1950) (sample 20, 247x). 20. *Pseudoclavulina maqfiensis* Le Roy, 1953 (sample 23, 247x). 21. *Pseudoclavulina sp.* (sample 6, 66x). 22. *Textularia farafraensis* Le Roy, 1953 (sample 11, 130x). 23. *Textularia nilotica* (Schwager, 1883) (sample 7, 168). 24. *Textularia schwageri* Le Roy, 1953 (sample 26, 168x). 25. Caudammina sp. (sample 5)

Remarks: its chambers more compressed and wall surface finer than in *M. Indentata*.

Genus: *Tritaxia* Reuss, 1860

Tritaxia barakai Said and Kenawy, 1956

Plate 3, figure 13

Tritaxia barakai Said and Kenawy, 1956, p. 123, pl. 1, fig.19; Waer, 1965, p. 53, pl. 2, fig. 1 and Shahin, 1988, p. 70, pl. 15, fig. 7 and Aly, *et al*. 2011, p. 83, pl. 1, fig. 10.

Remarks: This species is characterized by elongate, pyramidal triserial, triangular test; chambers numerous; sutures slightly depressed; wall arenaceous, smoothly finished; aperture terminal, rounded.

Genus: *Clavulinoides* Cushman, 1926

Clavulinoides aspera (Cushman, 1926)

Plate 3, figure 14

Clavulina trilatera Cushman var. *aspera* Cushman, 1926, p. 589, pl. 17, fig. 3; Cushman and Jarvis, 1932, p. 19, pl. 5, fig. 4.

Clavulinoides aspera (Cushman, 1926) - Cushman, 1937, p. 122, pl. 16, figs. 27-31; Le Roy, 1953, p. 25, pl. 1, figs. 5, 6; Waer, 1965, p. 37, pl. 1, figs. 11, 18 and Ayyad *et al.*, 1996b, Fig. 6 (h).

Tritaxia aspera (Cushman, 1926) - Hewaidy and El Ashwah, 1993a, pl.1, fig. 1.

Remarks: Test large, triangular with acute angles and parallel sides.

Clavulinoides trilaterus (Cushman, 1926)

Plate 3, figure 15

Clavulina trilatera Cushman, 1926, p. 588, pl. 17, fig. 2.

Clavulinoides trilatera (Cushman)-Said and Kenawy, 1956, p. 126, pl. 1, fig. 39.

Clavulinoides trilaterus (Cushman) - Le Roy, 1953, p. 26, pl. 1, figs. 9, 10; Hewaidyand El-Ashwah, 1993, pl. 1, fig. 1 and Hewaidy*et al*., 2014, p. 25, pl. 4, fig. 14.

Remarks: Test elongate; last chambers slightly rounded; aperture terminal.

Genus: *Pseudoclavulina* Cushman, 1936

Pseudoclavulina amorpha (Cushman, 1926)

Plate 3, figure 16

Clavulina amorpha Cushman, 1926, p. 589, pl. 17, fig. 3.

Pseudoclavulina amorpha (Cushman) - Said and Kenawy, 1956, p. 124, pl. 1, fig. 32.

Clavulina amorpha Cushman - Hewaidy and El Ashwah, 1993, pl. 1, fig. 7 and El Sharaawy*et al.*, 1995b, p. 10, pl. 2, fig. 7.

Remarks: Test short and less broad uniserial part than the early triserial part.

Pseudoclavulina clavata (Cushman, 1937)

Plate 3, figure 17

Pseudoclavulina clavata (Cushman), 1937, p. 108, pl. 15, figs. 1-13, Le Roy, 1953, p. 44, pl. 1, fig. 13 and Said and Kenawy, 1956, p. 125, pl. 1, fig. 28.

Remarks: Triserial part is longer than others *Pseudoclavulinoides.*

Pseudoclavulina farafraensis Le Roy, 1953

Plate 3, figures 18

Pseudoclavulina farafraensis Le Roy, 1953, p. 44, pl. 2, fig. 9 and Said and Kenawy, 1956, p. 125, pl. 1, fig. 29 and Hewaidy *et al.*, 2014, p. 26, pl. 4, fig. 15.

Clavulinafarafraensis (Le Roy) - Galal, 1995, p. 64, pl. 8, fig. 8.

Remarks: early portion triserial, sharply triangular, later portion uniserial, chambers nearly spherical.

Pseudoclavulina globulifera (Ten Dam and Sigal, 1950)

Plate 3, figures 19

Clavulina globulifera Ten Dam and Sigal, 1950, P. 32, Pl. 2, Fig. 7.

Pseudoclavulina globulifera (Ten Dam and Sigal) - Said and Kenawy, 1956, p.125, pl. 1, fig. 30; Ismail, 1989, p. 127, pl. 2, fig. 2 and Shahin, 1990, p. 500, pl. 12, fig. 7.

Remarks: sutures in uniserial part, depressed, wide and deeper than the other *Pseudoclavulina* species.

Pseudoclavulina maqfiensis Le Roy, 1953

Plate 3, figures 20

Pseudoclavulina maqfiensis, Le Roy, 1953, p. 44, pl. 2, figs. 16, 17; Waer, 1965, p. 50, pl. 1, fig. 14 and El Saadany, 1995, p. 108, pl. 3, figs. 5,6 and Hewaidy *et al*., 2014, p. 26, pl. 4, fig. 16.

Remarks: its test smaller than *P. farafraensis*.

Pseudoclavulinasp.

Plate 3, figures 21

Test small, early portion triserial, triangular in shape, later stage uniserial, chambers in early stage slighty distinct like a V shape, later chambers rounded, sutures in triserial part distinct, raised, uniserial sutures narrow, slightly depressed, periphery acute, wall arenaceous with finshly smooth, aperture terminal, rounded.

Remarks: this form differs from other *Pseudoclavulina* species in its triserial shorter, triangular in shape, first uniserial chamber low, smaller than other chambers.

Genus: *Textularia* Defrance, 1824

Textularia farafraensis Le Roy, 1953

Plate 3, figures 22

Textularia farafraensis Le Roy, 1953, p. 51, pl. 2, figs. 3, 4 and Said and Kenawy, 1956, p. 122, pl. 1, fig. 14 and Aly, *et al.* 2011, p. 83, pl. 1, fig. 12.

Remarks: test elongate, about twice as long as broad, chambers inflated, periphery broadly rounded, sutures depressed**.**

Textularia nilotica (Schwager, 1883)

Plate 3, figure 23

Plecaniumniloticum Schwager, 1883, p. 115, pl. 26, fig. 14 and Le Roy, 1953, p. 52, pl. 2, figs. 1, 2.

Textularia nilotica (Schwager, 1883), Aly, *et al*. 2011, p. 83, pl. 1, fig. 13 and Hewaidy *et al*., 2014, p. 26, pl. 4, fig. 17.

Remarks: its test elongate, broadly towards the apertural end.

Textularia schwageri Le Roy, 1953

Plate 3, figure 24

Textularia schwageri Le Roy, 1953, p. 52, pl. 2, figs. 5, 6.

Remarks: The species is characterizes by its compressed nature, appears to be restricted to the upper part.

Genus: *Caudammina* Montanaro-Gallitelli, 1955

Caudammina sp.

Plate 3 figure 25

Remarks: The species is flask shape, have a small branched at the base of test, chamber flattened.

5. Conclusions

The morphogroup analysis of the Paleocene/Early Eocene of agglutinated assemblages in the Tarawan and Esna Shale formations shows that all the morphogroups were present throughout the studied intervals (Figs. 2-5). Comparison of the results from the morphogroup analysis with the observation of recent and fossil foraminiferal assemblages leads to the conclusion that the benthic environments in the Wasif section, relatively low-oxygenated at Early Paleocene in Wasif section, while its well-oxygenated and stable at the resolution during the Late Paleocene/Early Eocene.

The high proportion of tubular forms (WS1) and common occurrenceof mostly elongated, infaunal forms (WS2, 4 and 5) and rounded planispiral (WS3) forms in the assemblages dominated by the deep-water agglutinated foraminifera (DWAF) suggest that the the early part of the Esna Shale Formation (El Hanadi Member) most probably deposited in a bathyal environment, possibly middle to lower bathyal, which is much deeper than a shelf environment suggested by Worsley *et al*. (1988).

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