ZIBELINE INTERNATIONAL™ PUBLISHING

Earth Sciences Malaysia (ESMY)

DOI: http://doi.org/10.26480/esmy.01.2024.52.60

ISSN: 2521-5035 (Print)
ISSN: 2521-5043 (Online)
CODEN: ESMACU

RESEARCH ARTICLE

PALEONTOLOGY, STRATIGRAPHY AND PALEOGEOGRAPHY OF THE SOUTHERN TETHYAN CAMPANIAN-NEOGENE CALCAREOUS BENTHIC FORAMINIFERAL SPECIES OF SUBORDERS: MILIOLINA, LAGENINA AND ROBERTININA

Haidar Salim Anan*

Professor of Stratigraphy and Micropaleontology, Al Azhar University-Gaza, Palestine
Corresponding Author Email: profanan@gmail.com

ARTICLE DETAILS

Article History:

Received 20 March 2024
Revised 14 April 2024
Accepted 21 May 2024
Available online 23 May 2024

ABSTRACT

One hundred and seven calcareous benthic foraminiferal species belong to thirty-five genera from seventeen countries in the Southern Tethys (Chile, Argentina, Tanzania, Algeria, Tunisia, Egypt, Palestine, Lebanon, Syria, Jordan, Saudi Arabia (SA), Yemen, Qatar, United Arab Emirates (UAE), Iraq, Iran, Pakistan) have been studied. The modern taxonomical consideration of the recorded species is used, which were previously noted in the literatures, while two of them are believed here as new: *Quinqueloculina tanzanica* and *Neoflabellina iraqensis*. Fifty-seven species of them are recorded from Egypt (~51%), 19 from Pakistan (~17.5%), 15 from UAE (~13.4%), Jordan and Argentina (~0.8%), Chile (~0.3%), Tanzania, SA and Yemen (~0.2%), the others counties one species. Most of the Southern Tethyan recorded species are endemic to their original description, while some of them are also recorded in some Northern Tethyan countries (i. e. France, Poland). Most of the Southern Tethyan assemblage indicates an open marine environment, which represents middle-outer neritic environment (100 m ~ 200 m depth), and shows an affinity with Midway-Type Fauna (MTF), while the littoral zones of the Middle East represent shallow neritic environment.

1. INTRODUCTION

During the past seven decades, the present author and other Southern Tethyan authors had been engaged in paleontology, stratigraphy and paleoenvironmental investigations of the calcareous benthic foraminiferal Campanian-Neogene succession in seventeen Southern Tethyan countries (Figure 1). Most of the species have been erected from Egypt (6 benthic genera and 55 species), Pakistan (1 genus and 19 species, Jordan (1 genus and 9 species), 14 species from UAE, 9 species from Argentina, and the other species were recorded from the other countries in the Southern Tethys. The taxonomic consideration, stratigraphic implication and the evolutionary lineages of some of the other erected taxa are presented and discussed.

Figure 1: Geographic locations of different countries in the Southern Tethys (A): Algeria, Tunisia, Libya, Egypt, Tanzania, Palestine, Lebanon, Syria, Jordan, Saudi Arabia (SA), United Arab Emirates (UAE), Yemen, Iraq, Iran and Pakistan, and (B): Chile and Argentina,

Quick Response Code	Access this article online	
	Website: www.earthsciencesmalaysia.com	**DOI:** 10.26480/esmy.01.2024.52.60

Cite The Article: Haidar Salim Anan (2024). Paleontology, Stratigraphy and Paleogeography of The Southern Tethyan Campanian-Neogene Calcareous Benthic Foraminiferal Species of Suborders: Miliolina, Lagenina and Robertinina. *Earth Sciences Malaysia, 8(1): 52-60.*

2. Material of Study

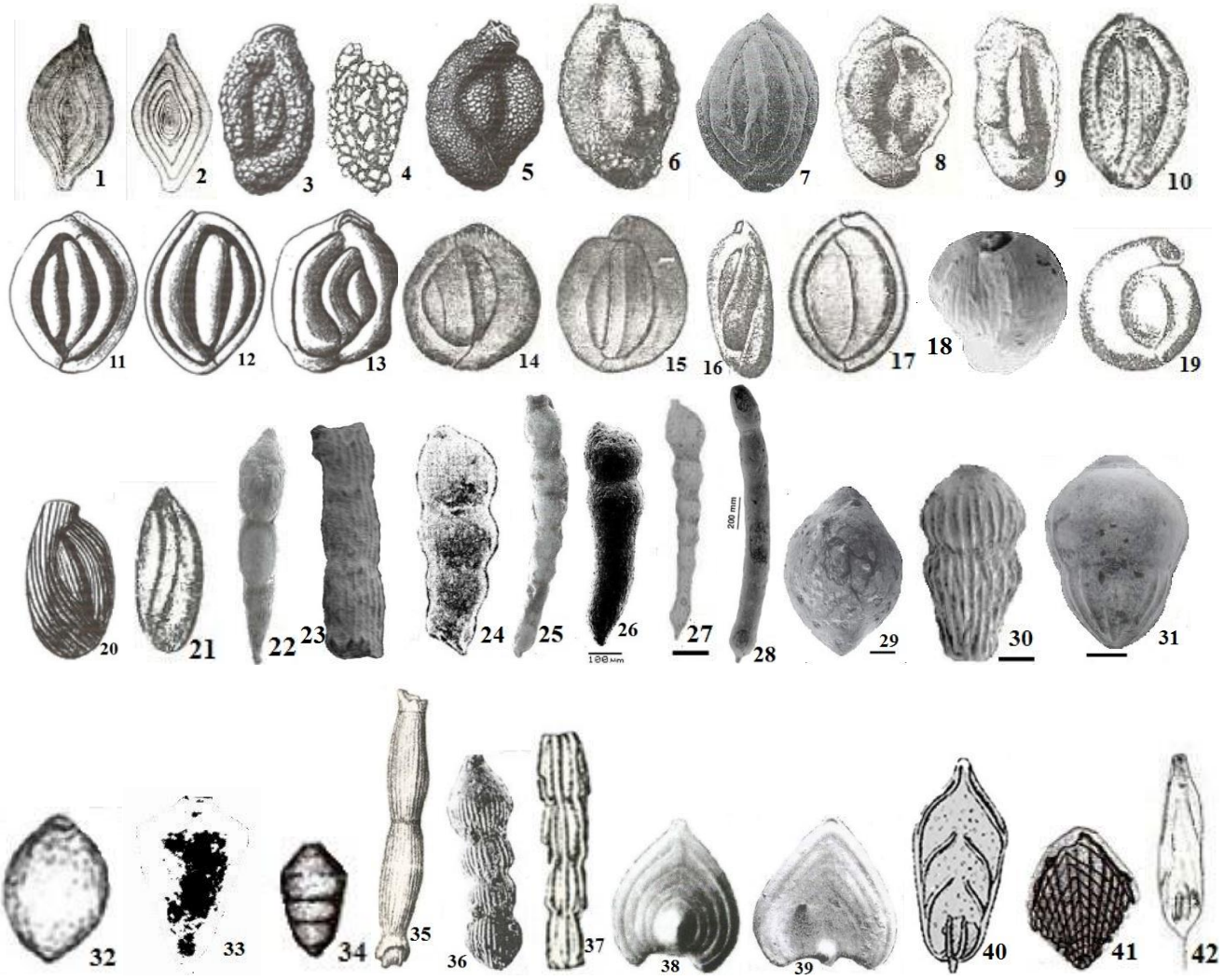
Rich and well-preserved 21 Miliolid, 88 Lagenid, and 1 Robertinina calcareous benthic foraminiferal species from many countries in the Southern Tethys (South America, North and East Africa, and Southwest Asia) made it possible to elucidate them with its modern taxonomical consideration, following the Code of Zoological Nomenclature. A taxonomic revision of two species of them is redescribed its morphological features, which are considered here as a new species.

3. Systematic Paleontology

The modern taxonomy of Loeblich & Tappan (1988) is followed here for one hundred and seven calcareous benthic foraminiferal species of three suborders Miliolina, Lagenina and Robertinina which are considered an excellent marker species for the Southern Tethys. The identified species are illustrated in Plate 1.

Plate 1 (Scale bars 100 µm)

Figure 1. *Spiroloculina haquei* Anan (2021), **2.** *S. pakistanica* Anan (2021), **3.** *Agglutinella compressa* El-Nakhal (1983), **4.** *A. reinemundi* (Haque, 1960), **5.** *A. robusta* El-Nakhal (1983), **6.** *A. sori* (Haque, 1960), **7.** *Ammomassilina misrensis* Anan (2021), **8.** *Dentostomina ammobicarinata* (Haque, 1960), **9.** *D. ammoirregularis* (Haque, 1960), **10.** *D. gapperi* (Haque, 1956), **11.** *Septloculina angulata* El-Nakhal (1990), **12.** *S. rotunda* El-Nakhal (1990), **13.** *S. tortuosa* El-Nakhal (1990), **14.** *Quinqueloculina inflata* Haque (1956), **15.** *Q. pseudosimplex* (Haque, 1960), **16.** *Q. pseudovata* Haque (1956), **17.** *Q. ranikotensis* Haque (1956), **18.** *Q. tanzanica* Anan, n. sp., **19.** *Triloculina psudoenoplostoma* Haque (1960), **20.** *T. reversaformis* El-Nakhal (1980), **21.** *T. sarahae* Haque (1956), **22.** *Chrysalogonium qarnelbarrensis* Anan (2022), **23.** *Dentalina tappanae* (Said & Kenawy, 1956), **24.** *Dentalinoides ghorabi* (Said & Kenawy, 1956), **25.** *Laevidentalina ameeri* Anan (2022), **26.** *L. hudae* Anan (2015), **27.** *L. jannoui* Anan (2023), **28.** *L. salimi* Anan (2009), **29.** *Lagenoglandulina argentinica,* Anan (2023), **30.** *Tollmannia argentinica* Anan (2023), **31.** *T. fingeri* Anan (2023), **32.** *Pseudonodosaria bulla* (Said and Kenawy, 1956), **33.** *P. conicus* Ismail (1992), **34.** *P. synaensis* Ansary (1955), **35.** *Pyramidulina leroyi* Anan (2020), **36.** *P. robinsoni* (Futyan, 1976), **37.** *P. semispinosa* (LeRoy, 1953), **38.** *Annulofrondicularia bignoti* (Anan, 2002) **39.** *A. nakkadyi* (Futyan, 1976), **40.** *Frondicularia esnehensis* Nakkady (1950), **41.** *F. gahannamensis* (Ansary, 1955) **42.** *F. nammalensis* Haque (1956), **43.** *F. pickeringi* Futyan (1976), **44.** *Tristix aubertae* Anan (2002), **45.** *Amphimorphina youssefi* Anan (1994), **46.** *Lenticulina ennakhali* Anan (2010), **47.** *L. reussi* (Haque, 1956), **48.** *Percultazonaria abunnasri* Anan (2015), **49.** *P. alii* Anan (2015), **50.** *P. allami* Anan (2015), **51.** *P. ameeri* Anan (2015), **52.** *P. carri* (LeRoy, 1953) **53.** *P. intercostata* (Nakkady, 1950), **54.** *P. jordanensis* (Futyan, 1976), **55.** *P. longiscata* (Nakkady, 1950) **56.** *P. wadiarabensis* (Futyan, 1976), **57.** *Lenticuzonaria argentinica* Anan (2023), **58.** *L. hodae* Anan (2021), **59.** *L. misrensis* Anan (2021), **60.** *Lenticubella kurkurensis* Anan (2022), **61.** *L. misrensis* Anan (2022), **62.** *L. polonica* Anan (2022), **63.** *Leroyia aegyptiaca* Anan (2020), **64.** *L. argentinica* Anan (2023), **65.** *L. maqfiensis* Anan (2020b), **66.** *L. tunisica* Anan (2020), **67.** *Percultalina misrensis* Anan (2022), **68.** *P. sinaensis* Anan (2022), **69.** *Saracenaria barnardi* Ansary (1955), **70.** *S. leroyi* Anan (1994), 71a. *Neoflabellina iraqensis* Anan, n. sp., 71b, *N. misrensis* Anan, n. sp., **72.** *Palmula americana* Anan (2023), **73.** *P. ansaryi* Anan (1994), **74.** *P. berggreni* (Anan, 2001), **75.** *P. gahannamensis* (Ansary, 1955), **76.** *P. salimi* Anan (2002), **77.** *P. undulata* Nakkady (1950), **78.** *P. woodi* Nakkady (1950), **79.** *Astacolus bifurcatus* LeRoy (1953), **80.** *A. vomeriformis* (Haque, 1956), **81.** *Hemirobulina bassiounii* Anan (1994), **82.** *H. olae* Anan (2015), **83.** *Marginulina argentinica* Anan (2023), **84.** *M. karimae* (Anan, 2009), **85.** *Vaginulinopsis argentinica* Anan (2023), **86.** *V. deserti* (Said and Kenawy, 1956), **87.** *V. emiratensis* Anan (1993), **88.** *V. nammalensis* (Haque, 1956), **89.** *V. fingeri* Anan (2023), **90.** *Vaginulinella fingeri* Anan (2023), **91.** *Citharina plummerae* Anan (2001), **92.** *Vaginulina boukharyi* (Anan, 2010), **93.** *V. chilensis* Anan (2023), **94.** *V. longiformis* Said & Kenawy (1956), **95.** *Lagena rawdhae* Anan (2020), **96.** *L. reticulatostriata* Haque (1956), **97.** *Procerolagena emiratensis* Anan (2022), **98.** *Ramulina elongata* Ismail (1992), **99.** *Ramulina futyani* Anan (2015), **100.** *Ramulina ismaili* Anan (2022), **101.** *Ramulina morsii* Anan (2023), **102.** *Ramulina orabii* Anan (2022), **103.** *Ramulina salahii* Anan (2022), **104.** *Ramulina shreifae* Anan (2023), **105.** *Ramulina subornata* Anan (2023), **106.** *Parafissurina pakistanica* Anan (2021), **107.** *Höglundina esnaensis* (LeRoy, 1953).




43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71a
71b
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
99
100
101
102
103
104
105
106
107

Order Foraminiferida Eichwald, 1830

I. Suborder Miliolina Delage And Hérouard, 1896

1) *Spiroloculina haquei* Anan , 2021a, p. 44, pl. 1, fig. 1. Paleocene, Pakistan.

2) *Spiroloculina pakistanica* Anan, 2021a, p. 44, pl. 1, fig. 2. Paleocene, Pakistan.

3) *Agglutinella compressa* El-Nakhal , 1983, p. 129, pl. 1, figs. 1-3, pl. 2, figs. 10, 11. Littoral zone of Gulf of Suez (Egypt), Jeddah, Saudi Arabia (SA) and also in the Gulf of Aqaba (Jordan).

4) *Agglutinella reinemundi* (Haque, 1960) (=*Triloculina reinemundi* Haque,1960, p.19, pl. 2, fig. 5). Eocene, Pakistan.

5) *Agglutinella robusta* El-Nakhal, 1983, p. 130, pl. 1, figs. 4-6, pl. 2, figs. 12. Littoral zone of Jeddah (SA), and also the Gulf of Suez (Egypt).

6) *Agglutinella sori* (Haque, 1960)(=*Triloculina sori* Haque,1960, p.20, pl.5, fig.9). Eocene, Pakistan.

7) *Ammomassilina misrensis* Anan, 2021b, p. 88, pl. 1, fig. 22 (=*Ammomassilina* sp. Anan,1994, p. 219, fig. 8.5). Eocene, Egypt.

8) *Dentostomina ammobicarinata* (Haque, 1960) (=*Triloculina ammobicarinata* Haque, 1960, pl. 6, fig. 6). Eocene, Pakistan.

9) *Dentostomina ammoirregularis* (Haque, 1960) (=*Triloculina ammoirregularis* Haque, 1960, pl. 6, fig. 4). Eocene, Pakistan.

10) *Dentostomina gapperi* (Haque, 1956) (=*Quinqueloculina gapperi* Haque, 1956, p. 54, pl. 32, fig. 11). Paleocene, Pakistan.

11) *Septloculina angulata* El-Nakhal, 1990, p. 91, pl.1, figs. 1-7. Littoral zone of sea shore of Tartus (Syria), Suez and Alexandria (Egypt), Beirut (Lebanon), Ajdabia (Libya), Aden and Hudaydah (Yemen), Jeddah (SA) and Djibouti.

12) *Septloculina rotunda* El-Nakhal, 1990, p. 91, pl. 1, figs. 8-11, pl. 2, figs. 1-3. Littoral zone of Tartus (Syria), Aden and Mukha (Yemen), Jeddah (SA), Suez and Alexandria (Egypt), Beirut (Lebanon), Ajdabia and Tripoli (Libya).

13) *Septloculina tortuosa* El-Nakhal, 1990,p. 91, pl. 2, figs. 4-9. Littoral zone of Alexandria (Egypt), Aden, Mukha and Hudaydah (Yemen).

14) *Quinqueloculina inflata* Haque, 1956 (=*Quinqueloculina lamarckiana* (d'Orbigny) var. *inflata* Haque, 1956, p. 55, pl. 32, fig. 3). Paleocene, Pakistan.

15) *Quinqueloculina pseudosimplex* (Haque, 1960) (=*Triloculina pseudosimplex* Haque, 1960, pl. 5, figs. 3, 4. Eocene, Pakistan.

16) *Quinqueloculina pseudovata* Haque, 1956, p. 66, pl. 25, figure 1. Paleocene, Pakistan.

17) *Quinqueloculina ranikotensis* Haque, 1956, p. 53, pl. 21, fig. 5; p. 58. Paleocene, Pakistan.

18) *Quinqueloculina tanzanica* Anan, n. sp.

Holotype: Plate 1, Figure 18.

Etymology: After the State of Tanzania, east Africa (Fig. 2A).

Stratigraphic level: Early Oligocene, TDP1(Fig. 2B)

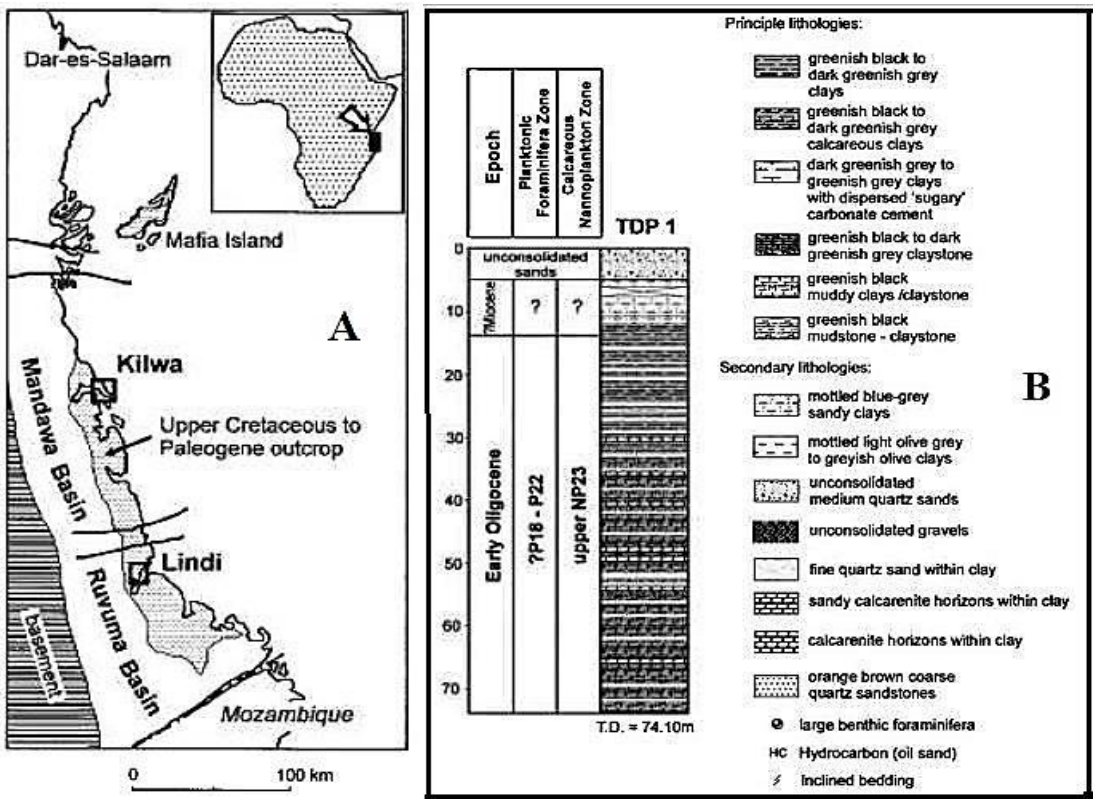


Figure 2: Location map of Tanzania (A), and the stratigraphy of the new species *Q. tanzanica* (B).

Diagnosis: This species has Quinqueloculine arrangement compressed test with elongated ornamented ribs parallel to the angled periphery, aperture is round with a small simple tooth with a short neck.

Remarks: This species differs from *Quinqueloculina carinata-striata* (Weisner) by its ornamented ribs not heavily costate which not parallel to the periphery but meet at it to form a small keel.

19) *Triloculina psudoenoplostoma* Haque, 1960 p. 19, pl. 6, fig. 3. Eocene, Pakistan.

20) *Triloculina reversaformis* El-Nakhal, 1980, p. 34, pl. 4, figs. 1-3. Sea shore, Hudaydah, Yemen.

21) *Triloculina sarahae* Haque, 1956, p. 59, pl. 32, figs. 5-8. Paleocene, Pakistan.

II. Suborder Lagenina Delage and Hérouard, 1896

22) *Chrysalogonium qarnelbarrensis* Anan, 2022a, p. 40, pl. 1, fig. 9 (=*Dentalina manifesta* Reuss - Abdelghany, 2003, p. 398, fig. 7.5). Maastrichtian, UAE.

23) *Dentalina tappanae* (Said and Kenawy, 1956), after Anan, 2011, p. 17, pl. 1, fig. 10 (=*Chrysalogonium tappanae* Said & Kenawy, 1956, p. 134, pl. 3, fig. 10). Loeblich & Tappan (1988) noted that the genus *Chrysalogonium* Schubert, among other characters, has rectilinear uniserial test with ovate

to subpyriform chambers and smooth surface, while genus *Dentalina* has elongate arcuate test with twenty fine longitudinal ribs. Maastrichtian-Paleocene, Egypt.

24) *Dentalinoides ghorabi* (Said and Kenawy, 1956) (=*Dentalina ghorabi* Said & Kenawy, 1956, p. 133, pl. 2, fig.27). Anan (2011) noted that *D. ghorabi* has smooth surface, among other characters, which must belongs to the genus *Dentalinoides*, not to *Dentalina* with its longitudinal ribs. Maastrichtian-Paleocene, Egypt.

25) *Laevidentalina ameeri* Anan, 2022a, p. 40, pl. 1, fig. 10 (=*Dentalina megalopolitana* Reuss - Abdelghany, 2003, p. 398, fig. 7.6). Maastrichtian, UAE.

26) *Laevidentalina hudae* Anan, 2015a, p. 65, pl. 1, fig. 1. Paleocene, UAE.

27) *Laevidentalina jannoui* Anan, 2023b, p. 36, pl. 1, fig. 1 (=*Dentalina* sp.- Jannou 2009, p. 177, fig. 6F). Eocene, Argentina.

28) *Laevidentalina salimi* Anan, 2009, p. 3, pl. 1, fig. 2. Eocene, UAE.

29) *Lagenoglandulina argentinica,* Anan, 2023a, p. 37, pl. 1, fig. 4 (=*Lagenoglandulina* A. Silvestri- Jannou et al., 2022, p. 36, pl. 3, fig. 3). Eocene, Argentina.

30) *Tollmannia argentinica* Anan, 2023a, p. 37, pl. 1, fig. 6) (=*Lingulina* sp.- Jannou, 2009, p. 101, fig. 6L). Eocene, Argentina. It most probably may develop into the Miocene *T. costata* (d'Orbigny).

31) *Tollmannia fingeri* Anan, 2023b, p. 42, pl. 1, fig. 4. This species differs from *T. costata* in its die out distally rib in the last chamber, and from *T. argentinica* Anan (2023) in its shorter test, and without surface longitudinal ribs in the final globular chamber, than whole test. Miocene, Chile.

32) *Pseudonodosaria bulla* (Said and Kenawy, 1956) (=*Rectoglandulina bulla* Said & Kenawy, 1956, p. 134, pl. 3, fig. 13). Paleocene, Egypt. Loeblich & Tappan (1988) noted that the genus *Pseudonodosaria* is considered as a senior synonym of the genus *Rectoglandulina* Loeblich & Tappan, 1955. Paleocene, Egypt.

33) *Pseudonodosaria conicus* Ismail, 1992, p.230, pl.1, fig.12. Maastrichtian, Egypt, UAE (Anan, 2011).

34) *Pseudonodosaria synaensis* Ansary, 1955, p. 55, pl. 1, fig. 25. Eocene, Egypt.

35) *Pyramidulina leroyi* Anan, 2020a, p. 4, pl. 1, fig. 10 (=*Nodosaria* sp. LeRoy, 1953, p. 41, pl. 4, fig. 9). Paleocene-Eocene, Egypt.

36) *Pyramidulina robinsoni* (Futyan, 1976) (=*Nodosaria robinsoni* Futyan, 1976, p. 525, pl. 82, figs. 5, 6). *P. robinsoni* differs from *P. leroyi* in its inflated shape, lesser test- size and number of the uniserial chambers in the Paleocene *P. robinsoni* (Futyan)→Paleocene-Eocene *P. leroyi* lineage (Anan, 2020). Paleocene, Jordan, Egypt (Anan, 2020) and Tanzania (Pearson et al, 2006).

37) *Pyramidulina semispinosa* (LeRoy, 1953) (=*Nodosaria semispinosa* LeRoy, 1953, p. 41, pl. 4, fig. 10). Eocene, Egypt.

38) *Annulofrondicularia bignoti* (Anan, 2002) (=*Frondicularia bignoti* Anan, 2002, p. 632, fig. 2.2). Paleocene, Egypt.

39) *Annulofrondicularia nakkadyi* (Futyan, 1976) (=*Frondicularia nakkadyi* Futyan, 1976, p. 528, pl. 82, fig.1). Paleocene, Jordan, Qatar (Hewaidy & Hitmi, 1993) and Egypt (Anan, 2002).

40) *Frondicularia esnehensis* Nakkady, 1950, p. 685, pl. 89, fig. 23. Campanian-Maastrichtian, Egypt.

41) *Frondicularia gahannamensis* (Ansary, 1955) (=*Flabellina gahannamensis* Ansary, 1955, p. 28, pl.1, fig. 9). Eocene, Egypt.

42) *Frondicularia nammalensis* Haque, 1956 (=*Frondicularia linearis* Franke var. *nammalensis* Haque, 1956, p. 90, pl. 21, figs. 3, 4. Paleocene, Pakistan.

43) *Frondicularia pickeringi* Futyan, 1976, p. 526, pl. 82, fig. 2. Paleocene, Jordan.

44) *Tristix aubertae* Anan, 2002, p. 634, fig. 2. 6. Paleocene, Egypt.

45) *Amphimorphina youssefi* Anan, 1994, p. 220, fig. 8. 7. Eocene, Egypt and UAE (Anan, 2011).

46) *Lenticulina ennakhali* Anan, 2010, p. 20, fig. 2. Paleocene-Eocene, Egypt.

47) *Lenticulina reussi* (Haque, 1956) (=*Robulus reussi* Haque,1956, p. 66, pl. 28, fig 4) Eocene, Pakistan.

48) *Percultazonaria abunnasri* Anan, 2015a, p. 16, pl. 1, fig. 1. Eocene, Egypt.

49) *Percultazonaria alii* Anan, 2015a, p. 16, pl. 1, fig. 2. Paleocene, Egypt.

50) *Percultazonaria allami* Anan, 2015a, p. 17, pl. 1, fig. 3. Paleocene, Egypt.

51) *Percultazonaria ameeri* Anan, 2015a, p. 17, pl. 1, fig. 4. Paleocene, Egypt.

52) *Percultazonaria carri* (LeRoy, 1953)(=*Marginulina carri* LeRoy, 1953, p. 38, pl. 4, figs. 4,5). Eocene, Egypt.

53) *Percultazonaria intercostata* (Nakkady, 1950) (=*Marginulina wetherilli* Jones var. *intercostata* Nakkady,1953, p. 684, pl. 89, fig. 12). Paleocene, Egypt.

54) *Percultazonaria jordanensis* (Futyan, 1976) (=*Marginulina jordanensis*, Futyan, 1976, p. 525, pl. 81, figs. 5, 6. Eocene, Egypt.

55) *Percultazonaria longiscata* (Nakkady, 1950) (=*Marginulina wetherilli* Jones var. *longiscata* Nakkady, 1950, p. 684, pl. 89, fig. 13. Eocene, Egypt.

56) *Percultazonaria wadiarabensis* (Futyan, 1976) (=*Vaginulinopsis wadiarabensis* Futyan, 1976, p. 524, pl. 81, figs. 7-9). Paleocene, Jordan and Egypt (Anan, 2015).

57) *Leticuzonaria argentinica* Anan, 2023a, p. 37, pl. 1, fig. 9 (=*Marginulina asperuliformis* (Nuttall) - Jannou, 2009, p. 179, fig. 6P). Eocene, Argentina.

58) *Leticuzonaria hodae* Anan, 2021a, p. 34, pl. 1, fig. 3. Paleocene, Jordan.

59) *Leticuzonaria misrensis* Anan, 2021a, p. 34, Pl. 1, figs. 5-8. Paleocene, Egypt.

60) *Lenticubella kurkurensis* Anan, 2022d, p.19, pl.1, fig.3 (=*Saracenaria* sp. Ali,2003, pl.6, fig. 21). Paleocene, Egypt.

61) *Lenticubella misrensis* Anan, 2022b, p. 19, pl. 1, fig. 4 (=*Saracenaria* sp. Ali, 2003, pl. 5, fig. 13). Paleocene, Egypt.

62) *Lenticubella polonica* Anan, 2022b, p. 19, pl. 1, fig. 2 (=*Darbyella irregularis* Pożaryska, 1965, p. 66, pl. 8, fig. 6). Paleocene, Poland.

63) *Leroyia aegyptiaca* Anan, 2020b, p. 54, pl. 1, fig. 8 (=*Marginulina* sp. C- LeRoy, 1953 p. 38, pl. 8, fig. 8). Eocene, Egypt.

64) *Leroyia argentinica* Anan, 2023a, p. 38, pl.1, fig.13 (=*Marginulina* ex gr. *M. hochstetteri* Stache -Jannou et al. 2022, p. 38, pl. 2, fig. 17). Eocene, Argentina.

65) *Leroyia maqfiensis* Anan, 2020b, p. 54, pl. 1, fig. 10 (=*Marginulina* sp. D- LeRoy, 1953, p. 39, pl. 10, fig. 24). Eocene, Egypt.

66) *Leroyia tunisica* Anan 2020b, p. 55, pl. 1, fig. 13. Paleocene, Tunisia.

67) *Percultalina misrensis* Anan, 2022c, p. 32, pl. 1, fig. 2 (=*Marginulinopsis tuberculata* (Plummer) - Youssef and Taha, 2012, p. 4289, pl. 2, fig. 18). Paleocene, Egypt.

68) *Percultalina sinaensis* Anan, 2022c, p. 32, pl. 1, fig. 3 (=*Marginulinopsis brantlyi* - Abul-Nasr, 2000, p. 68, fig. 14. 6). Eocene, Egypt.

69) *Saracenaria barnardi* Ansary, 1955, p. 59, pl. 2, fig. 5. Eocene, Egypt.

70) *Saracenaria leroyi* Anan, 1994, p. 222, fig. 8. 14, 15. Eocene, Egypt.

71a) *Neoflabellina iraqensis* Anan, n. sp. (=*Neoflabellina* sp., Jaff, 2021, p. 8, fig. 4D).

Holotype: Plate 1, Figure 71a.

Etymology: After the Republic of Iraq (Fig. 3A).

Type locality: Shiranish Formation, Azmer section, Kurdistan region, NE Iraq (Fig. 3B).

Age: Campanian.

Diagnosis: Test large, up to 5 mm in length and 1.8 mm in breadth, palmate to rhomboid in outline and flattened, fewer coiled early chambers in a planispiral rectilinear, higher elevated sutures with irregularly shaped loops and break up into nodes, aperture terminal on neck and radiate.

Remarks: This species differs from *N. numismalis* by its less number and height uniserial portion, less regular rounded periphery, and break up sutures into nodes.

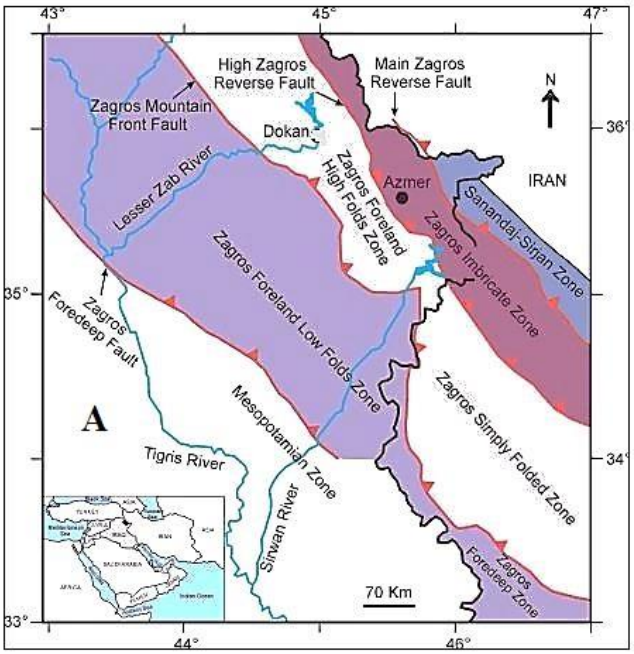


Figure 3A: Location map of the Azmer section, Kurdistan region, NE Iraq (Jaff, 2021).

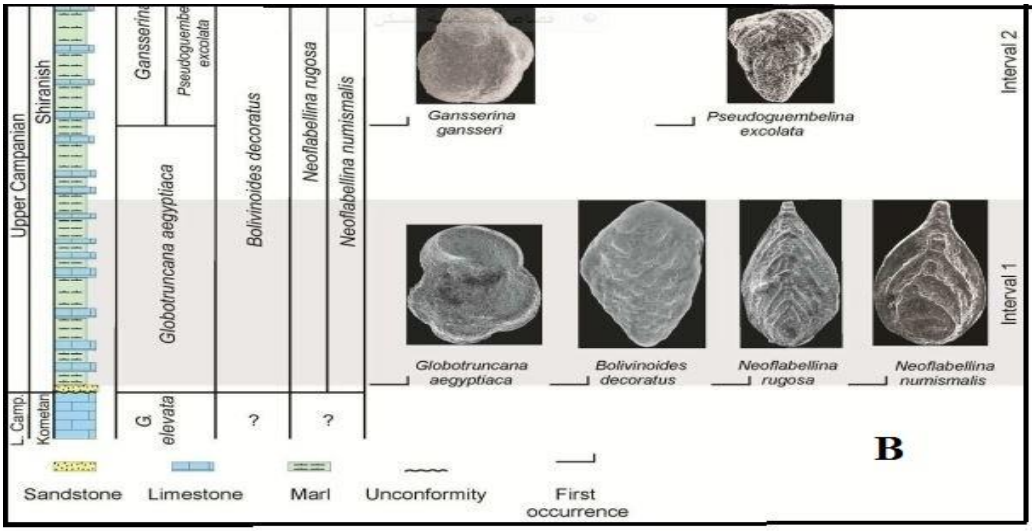


Figure 3B: Bio- and stratigraphic log of the Azmer section, Kurdistan region, NE Iraq (Jaff, 2021).

71b) Neoflabellina misrensis Anan, n. sp. (=*Neoflabellina* sp. of Youssef and Taha, 2012, pl. 2, fig. 14).

Holotype: Plate 1, Figure 71b.

Etymology: After the Arab Republic of Egypt (Misr) (Fig. 4A).

Type locality: Esna Formation, Qreiya section, north of Qena, Southern Egypt (Fig. 4B).

Age: Paleocene (P5).

Figure 4A: Location of Qreiya section, north of Qena, Southern Egypt.

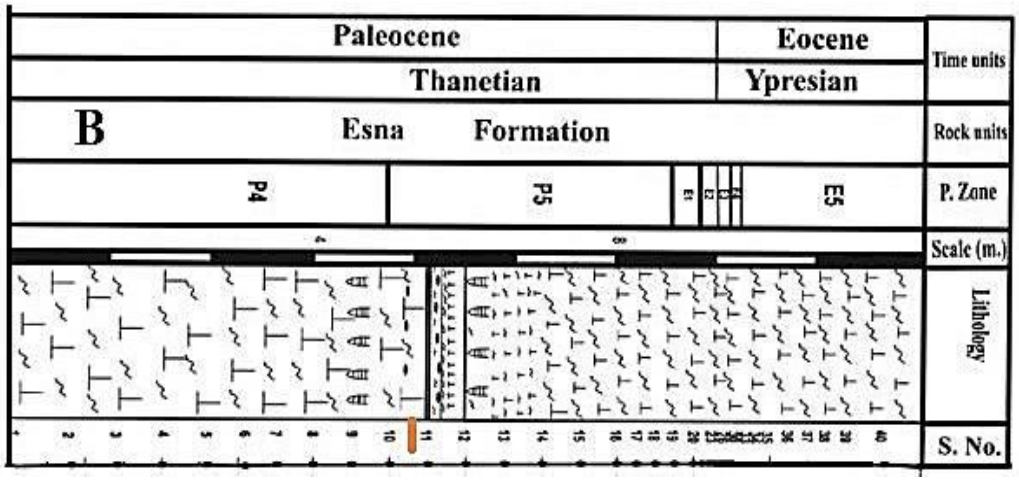


Figure 4B: Stratigraphic log of Qreiya section, and location of sample 11 of in *N. misrensis.*

Diagnosis: Test elongate, tapering terminal last chamber, fewer coiled early chambers in a planispiral rectilinear, higher elevated sutures, aperture terminal on neck.

Remarks: This new species differs from *N. iraqensis* by its elongated test and tapering terminal last chamber.

72) *Palmula americana* Anan, 2023a, p. 38, pl. 1, fig. 11(=*Palmula* sp. cf. *P. magallanica* Todd & Kniker - Jannou, 2009, p. 179, fig. 7B). Eocene, Argentina.

73) *Palmula ansaryi* Anan, 1994, p. 222, fig. 8. 14, 15. Eocene, Egypt.

74) *Palmula berggreni* (Anan, 2001)(=*Planularia berggreni* Anan, 2001, p. 138, pl. 1, fig. 2). Paleocene, Egypt.

75) *Palmula gahannamensis* (Ansary, 1955) (=*Flabellina gahannamensis* Ansary, 1955, p. 28, pl.1, fig. 9). Eocene, Egypt.

76) *Palmula salimi* Anan, 2002, p. 636, fig. 2. 7. Paleocene, Egypt.

77) *Palmula undulata* Nakkady 1950 (*Palmula woodi* var. *undulata* Nakkady, 1950, p. 685, pl. 89, fig. 25). Paleocene, Egypt.

78) *Palmula woodi* Nakkady, 1950 (=*Palmula woodi* Nakkady,1950, p. 684, pl. 89, fig. 24). Paleocene, Egypt.

79) *Astacolus bifurcatus* LeRoy, 1953, p.19, pl.4, figs.1,2. Maastrichtian-Paleocene, Egypt, UAE(Anan, 1993).

80) *Astacolus vomeriformis* (Haque, 1956) (=*Dentalina* (?) *vomeriformis* Haque,1956, p. 78, pl. 23, fig. 9. Paleocene, Pakistan.

81) *Hemirobulina bassiounii* Anan, 1994, p. 223, fig. 8.16. Eocene, Egypt.

82) *Hemirobulina olae* Anan, 2015b, p. 71, pl. 1, fig. 8. Paleocene, UAE.

83) *Marginulina argentinica* Anan, 2023a, p. 38, pl. 1, fig. 15) (= *Lenticulina* sp.-Jannou, 2009, p. 179, fig. 6U). Ypresian, Argentina.

84) *Marginulina karimae* (Anan, 2009) (=*Marginulinopsis karimae* Anan, 2009, p. 6, pl. 1, fig. 8). Eocene, UAE.

85) *Vaginulinopsis argentinica* Anan, 2023a (=*Laevidentalina* sp. A-Jannou et al., 2022, p. 21, pl. 2, fig. 5). Eocene, Argentina.

86) *Vaginulinopsis deserti* (Said and Kenawy, 1956) (=*Marginulinopsis deserti* Said and Kenawy,1956, p. 132, pl. 2, fig. 23). Maastrichtian-Paleocene, Egypt.

87) *Vaginulinopsis emiratensis* Anan, 1993, p. 657, pl. 2, fig. 12. Maastrichtian, UAE.

88) *Vaginulinopsis nammalensis* (Haque, 1956) (=*Marginulina glabra* d'Orbigny *nammalensis* var. Haque, 1956, p.74, pl.11, figs. 1-4). Paleocene-Eocene, Pakistan, France (Sztrákos, 2005) and UAE (Anan, 2009).

89) *Vaginulinoides fingeri* Anan, 2023b (=*Vaginulinopsis carinata* (Silvestri) - Loeblich & Tappan, 1988, p. 412, pl. 450, fig. 4). Oligocene, Cuba and Chile.

90) *Vaginulinella fingeri* Anan, 2023b, p. 92, pl. 5, fig. 5 (=*Vaginulinopsis carinata* (Silvestri) - Loeblich & Tappan, 1988, p. 412, pl. 450, figs. 5, 6; *Dentalina obliquecostata* (Stache)-Finger, 2013. p. 400, pl. 6, fig. 21). Miocene, Chile.

91) *Citharina plummerae* Anan, 2001, p. 135, pl. 1, fig. 1. Paleocene, Egypt.

92) *Vaginulina boukharyi* (Anan, 2010) (=*Vaginulinopsis boukharyi* Anan, 2010, p.30, pl. 1, fig. 12). Paleocene, Egypt.

93) *Vaginulina chilensis* Anan, 2023c, p. 49, pl. 1, fig. 19 (=*Astacolus mexicanus* (Nuttall) - Finger, 2013, p. 415, pl. 9, fig. 19). Miocene, Chile.

94) *Vaginulina longiformis* Said & Kenawy, 1956, p.134, pl. 3, fig.5a. Maastrichtian-Paleocene, Egypt.

95) *Lagena rawdhae* Anan, 2020a, p. 5, pl. 1. 23. Paleocene-Eocene, Egypt.

96) *Lagena reticulatostriata* Haque, 1956, pl. 23, figs. 4, 5. Paleocene, Pakistan.

97) *Procerolagena emiratensis* Anan, 2022a, p. 41, pl. 2, fig. 16) (=*Pyramidulina* sp. Abdelghany, 2003, p. 399, fig. 8.7. Maastrichtian, UAE.

98) *Ramulina elongata* Ismail, 1992, p. 234, pl. 1, fig. 21. Paleocene-Eocene, Egypt.

99) *Ramulina futyani* Anan, 2015b, p. 72, pl. 1, fig. 11. Paleocene, UAE.

100) *Ramulina ismaili* Anan, 2022d, p. 2, fig. 2.6. Maastrichtian-Paleocene, Egypt.

101) *Ramulina morsii* Anan, 2023a, p. 39, pl. 1, fig. 20 (=*Ramulina* sp.-Jannou, 2009, p. 104, fig. 7G). Ypresian, Argentina.

102) *Ramulina orabii* Anan, 2022d, p. 2, fig. 1.3. Paleocene-Eocene, Egypt.

103) *Ramulina salahii* Anan, 2022d, p. 5, fig. 3.5. Eocene, Iran.

104) *Ramulina shreifae* Anan, 2023c, p. 49, pl. 6, fig. 8. Eocene, Egypt.

105) *Ramulina subornata* Anan, 2023a, p. 39, pl. 1, fig. 18) (= *Ramulina* sp. cf. *globulifera* Brady-Jannou, 2009, p. 104, fig. 7F). Eocene, Argentina.

106) *Parafissurina pakistanica* Anan, 2021a, p. 45, pl. 2, fig. 7 (=*Lagena* sp. Haque, 1956, p. 103, pl. 32, fig.15). Eocene, Pakistan.

III. Suborder Robertinina Loeblich & Tappan, 1984

107) *Höglundina esnaensis* (LeRoy, 1953) (=*Epistomina esnaensis* LeRoy,1953, p. 29, pl. 5, figs 7-9). Eocene, Egypt.

4. PALEOGEOGRAPHY

Most of the one hundred and seven Southern Tethys recorded species from three Suborders Miliolina, Lagenina and Robertinina are an endemic to its original erection in the seventy countries of the Southern Tethys in South America, North and East Africa and southwest Asia (see Fig. 1). Some of the identified species are also recorded in the Southern Tethys

and also some countries in the Northern Tethys (i.e. France and Poland). The existence of a marked differences between the number of recorded benthic foraminiferal species in the closest or farest localities in the Southern and Northern Tethys may be due to many causes: the differences in the paleoenvironmental the deficiency of available literatures, or also due to less homogeneity in the species concept between different authors.

5. Paleoenvironment

The paleogeographic maps of some authors show the Tethyan realm had been connected with the Indo-Pacific Ocean from the east and Atlantic Ocean to the west via Mediterranean Sea crossing the Middle East region during the Campanian-Neogene (e.g. Solakius et al., 1990; Anan, 1995; Rögl, 1999; Rosenbaum et al., 2002; Abed, 2013) (Fig. 5).

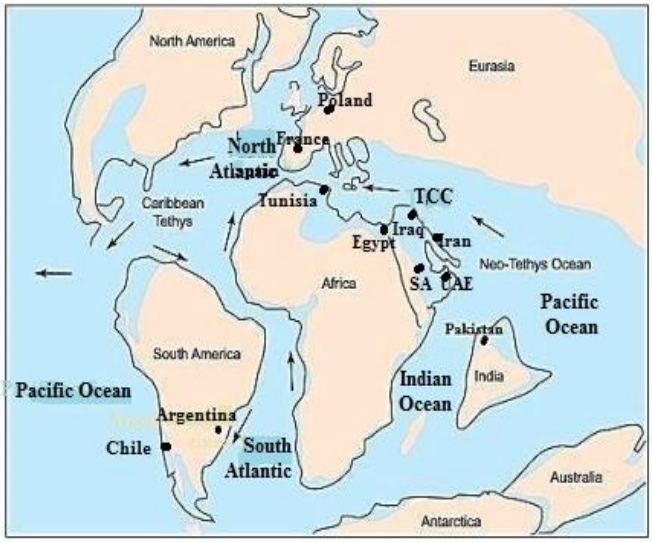


Figure 5: The Neo-Tethys Ocean around K/T showing the flow direction of the Tethyan Circumglobal Current (TCC) from east to west and south to north (after Abed, 2013).

The probable environment of the Southern America, Mediterranean and Pakistan Basins is middle neritic-upper bathyal (100-400 m) after many authors (e. g. LeRoy, 1953; Haque, 1956, 1960; Berggren & Aubert, 1975; Anan, 1994; Khawaj et al, 2018; Jannou et al, 2022), except the Littoral Zones of Mediterranean Sea, Gulf of Suez, Gulf of Aqaba and Red Sea have shallow inner neritic environment. The number differences of the recorded species between the different localities in the Southern Tethys may be due to not detailed study, different environmental parameters and/or misidentification.

6. Conclusion

One-hundred and seven Campanian-Neogene benthic foraminiferal species of three suborders Miliolina, Lagenina and Robertinina from seventeen countries in South America and Middle East made it possible to elucidate them with its modern taxonomical consideration and its probable evolutionary trends of some of them. Most of the identified species are recorded from Egypt (~51%), Pakistan (~17.5%) and UAE (~13.5%). Two out of the identified species are believed here to be new: *Quinqueloculina tanzanica* and *Neoflabellina iraqensis*. The paleodepths of the identified benthic foraminifera are inferred from the bathymetric distributions of the individual species or genera reported for the Campanian-Neogene and littoral zones of the Mediterranea and Red seas, as well as Suez and Aqaba of gulfs. The paleontology, stratigraphy are a product of eustasy, tectonics and pattern of sedimentation.

Acknowledgement

The author thanks the editor of Earth Sciences Malaysia (ESMY), and my daughter Dr. Huda Anan for her help in preparing the figures and plate.

References

Abdelghany, O., 2003. Late Campanian-Maastrichtian foraminifera from the Simsima Formation on the western side of the Northern Oman Mountains. Cretaceous Research, 24, Pp. 391-405.

Abed, A.M., 2013. The eastern Mediterranean phosphorite giants: An interplay between tectonics and upwelling. Geo Arabia, 18 (2), Pp. 67–94.

Abul-Nasr, R.A., 2000. Middle-Upper Eocene benthic foraminifera of Wadi Tayiba and Wadi Bagha (western Sinai): A comparative study. Middle East Research Center, Ain Shams University, Earth Science Series, Cairo, 14, Pp. 49-76.

Ali, M.Y., 2003. Micropaleontological and stratigraphical analyses of the Late Cretaceous/Early Tertiary succession of the Southern Nile Valley (Egypt). Der Fakultät für Geowissenschaften an der Ruhr-Universität Bochum vorgelegte Dissertation zur Erlangung des Grades eines, Pp. 1-197.

Anan, H.S., 1994. Benthic foraminifera around Middle/Upper Eocene boundary in Egypt. Middle East Research Center, Ain Shams University, Earth Science Series, Cairo, 8, Pp. 210-233.

Anan, H.S., 1995. Late Eocene biostratigraphy of Jabals Malaqet and Mundassa of Al Ain region, United Arab Emirates. Revue de Micropaléontologie, 38 (1), Pp. 3-14.

Anan, H.S., 2001. Paleocene Vaginulininae (benthic foraminifera) of Duwi section, Red Sea coast, Egypt. Egyptian Journal of Paleontology, 1, Pp. 135-139.

Anan, H.S., 2002. Stratigraphy and paleobiogeography of some Frondicullariinae and Palmulinae benthic foraminiferal general in the Paleocene of Egypt (Misr). Neues Jahrbuch für Geologie und Paläontologie, Mh., 10, Pp. 629-640.

Anan, H.S., 2009. Paleontology and stratigraphical distribution of suborder Lagenina (benthic foraminifera) from the Middle-Late Eocene Mazyad Member of the Dammam Formation in Jabal Hafit, Al Ain area, United Arab Emirates, Northern Oman Mountains. Revue de Paléobiologie, 28 (1), Pp. 1-18.

Anan, H.S., 2010. *Lenticulina ennakhali* n. sp. (benthic foraminifera) from the Paleocene-Early Eocene succession of Abu Zenima section, west central Sinai, Egypt (Misr). 1st International Conference for Basic and Applied Sciences (ICBAS), Gaza, Palestine, 2010, Pp. 19-22.

Anan, H.S., 2011. Paleontology, paleoenvironments, palaeogeography and stratigraphic value of the Ma as trichtian-Paleogene and Recent foraminiferal species of Anan in the Middle East. Egyptian Journal of Paleontology, 11, Pp. 49-78.

Anan, H.S., 2015a. Paleocene Lagenid benthic foraminifera of Jabal Mundassa, Al Ain Area, United Arab Emirates. Egyptian Journal of Paleontology, 15, Pp. 61-83.

Anan, H.S., 2015b. Paleogene Lagenid Percultazonarias (Foraminifera) in Egypt: paleontology, stratigraphy, paleogeography and some taxonomical considerations. Egyptian Journal of Paleontology, 15, Pp. 13-30.

Anan, H.S., 2020a. Early Paleogene benthic foraminifera of Duwi section, Red Sea coast, Egypt. Journal of American Science, 16 (2), Pp. 1-22.

Anan, H.S., 2020b. Leroyia, a new Tethyan Lagenid benthic foraminiferal genus. Earth Sciences Pakistan (ESP), 4 (2), Pp. 53-57.

Anan, H.S., 2021a. Paleontology and paleoenvironment of the Early Paleogene Pakistanian benthic foraminiferal species of Haque. Suborders Miliolina and Lagenina. Earth Sciences Pakistan (ESP), 5 (1), Pp. 42-47.

Anan, H.S., 2021b. Paleontology, stratigraphy, paleoenvironment and paleogeography of the seventy Tethyan Maastrichtian-Paleogene foraminiferal species of Anan, a review. Journal of Microbiology & Experimentation, 9 (3), Pp. 81-100.

Anan, H.S., 2021c. Lenticuzonaria, A new Tethyan Lagenid benthic foraminiferal genus. Earth Sciences Pakistan (ESP), 5 (1) Pp. 33-36.

Anan, H.S., 2022a. Evaluation of the Maastrichtian to Priabonian benthic foraminiferal type specimens from the United Arab Emirates (UAE). 4thInternational Conference for Basic and Applied Sciences (ICBAS), Gaza, Palestine, 24, Pp. 36-52.

Anan, H.S., 2022b. Lenticubella: A new Tethyan Lagenid benthic foraminiferal genus. Earth Science Pakistan (ESP), 6 (1), Pp. 17-21.

Anan, H.S., 2022c. Percultalina: A new Lagenid benthic foraminiferal

genus. Earth Science Pakistan (ESP), 6 (2), Pp. 30-35.

Anan, H.S., 2022d. On the variability of benthic foraminiferal species of the genus Ramulina in the Tethys. Journal of Foraminiferal Research, 52 (3), Pp. 1-7.

Anan, H.S., 2023a. Taxonomical consideration, phylogeny and paleogeography of some Argentinian Early Paleogene benthic foraminiferal species. Earth and Planetary Science, 2 (1), Pp. 33-43.

Anan, H.S., 2023b. Contribution to the Knowledge of Twenty Members of the Lagenid Benthic Foraminifera in the Southern Tethys. Earth and Planetary Science, 02 (02), Pp. 38-54.

Anan, H.S., 2023c. Contribution to the Knowledge of Twenty Members of the Lagenid Benthic Foraminifera in the Southern Tethys. Earth and Planetary Science, 02 (02), Pp. 38-54.

Ansary, S.E., 1955. Report on the foraminiferal fauna from the Upper Eocene of Egypt. Publication de l'Institut du Desert d'Egypt, Pp. 1-160.

Berggren, W.A., Aubert, J., 1975. Paleocene benthonic foraminiferal biostratigraphy, paleobiogeography and paleoecology of Atlantic-Tethyan regions: Midway-type fauna. Palaeogeography, Palaeoclimat ology, Palaeoecology, 18, Pp. 73-192.

El-Nakhal, H. A., 1983. Agglutinella, a new Miliolids genus (Foraminiferida). Journal of Foraminiferal Research, 13 (2), Pp. 129-133.

El-Nakhal, H.A., 1990. Septloculina, a new genus in Haurininae (Foraminiferida). Micropaleontology, 36 (1), Pp. 88-95.

Futyan, A.I., 1976. Late Mesozoic and Early Cainozoic benthonic foraminifera from Jordan. Palaeontology, 19 (3), Pp. 53-66.

Haque, A.F.M.M., 1956. The foraminifera of the Ranikot and the Laki of the Nammal Gorge, Salt Range, Pakistan. Pakistan Geological Survey Memoir, Palaeontologica Pakistanica, 1, Pp. 1-229.

Haque, A.F.M.M., 1960. Some middle to late Eocene smaller foraminifera from the Sor Rang, Quetta District, West Pakistan. Pakistan Geological Survey Memoir, Palaeontologica Pakistanica, 2 (2), Pp. 9-57.

Hasson, P.H., 1985. New observations on the biostratigraphy of the Saudi Arabian Umm er Radhuma Formation (Paleogene) and its correlation with neighboring regions. Micropaleontology,31(4), Pp.335-364.

Ismail, A.A., 1992. Some Upper Cretaceous benthic foraminifera from Sufr El Dara, Eastern Desert, Egypt. Egyptian Journal of Egypt, 35 (1-2), Pp. 221-243.

Jaff, R.B.N., 2021. Biostratigraphy of Bolivinoides and Neoflabellina benthic foraminifera in the Upper Cretaceous Shiranish Formation, Kurdistan Region, NE Iraq. Iraqi Bulletin of Geology and Mining, 17 (1), Pp. 1-13.

Jannou, G.E., 2009. Microfósiles Marinos del Eoceno inferior, Isla Grande de Tierra Del Fuego, Argentina: bioestratigrafía, paleoambiente y paleobiogeografía. Biblioteca Digital, Universidad de Buenos Aires (UBA), Facultad de Ciencias Exactas Naturales (FCEN), Pp. 1-228.

Jannou, G.E., Náñez, C.A., Malumián, N., 2022. Foraminíferos bentónicos de la Formación Punta Torcida, Eoceno inferior-medio (YpresianoLutetiano inferior), Isla Grande de Tierra del Fuego y plataforma continental fueguina. Serie Contribuciones Técnicas. Geología Regional N° 9, Pp. 1-53.

Khawaj, M.S., Faisal, M., Ur Rehman, Q., Ahmad, T., Khattak, S.A., Saeed, A., Adnan, M.T., Irfan, Ur Rehman, S., Ahmed, I., Ishfaque, M., 2018. Benthic foraminiferal biostratigraphy, microfacies analysis and depositional environment of Chorgali Formation Yaadgar section, Muzaffarabad, Pakistan. Pakistan Journal of Geology (PJG), 2 (1), Pp. 21-29.

LeRoy, L.W., 1953. Biostratigraphy of Maqfi section, Egypt. Geological Society of American Memoir, 54 Pp. 1-73.

Loeblich, A.R., Tappan, H., 1988. Foraminiferal genera and their classification. Van Nostrand Reinhold (VNR), New York, Part 1, Pp.1-970, part 2, Pp. 1-847.

Nakkady, S.E., 1950. A new foraminiferal fauna from the Esna Shale and Upper Cretaceous chalk of Egypt. Journal of Paleontology, 24 (6), Pp. 675-692.

Pearson, P.N., Nicholas C.J., Singano, J.M., Bown, P.R., Coxall, H.K., van Dongen, B.E., Huber, B.T., Karega, A., Lees, J.A., MacLeod, K., McMillan, I.K., Pancost, R.D., Pearson, M., Msaky, E., 2006. Further Paleogene and Cretaceous sediment cores from the Kilwa area of coastal Tanzania: Tanzania Drilhng Project Sites 6-10. Journal of African Earth Sciences 45, Pp. 279-317.

Pożaryska, K., 1965. Foraminifera and biostratigraphy of the Danian and Montian in Poland. Paleontologica Polonica, Warsaw, 14, Pp. 156.

Rögl, F., 1999. Mediterranean and Paratethys. Facts and hypotheses of an Oligocene to Miocene paleogeogra phy (short overview). Geologica Carpathica, 50 (4), Pp. 339-349.

Rosenbaum, G., Lister, G.S., Duboz, C. 2002. Relative motions of Africa, Iberia and Europe during Alpine orogeny. Tectonophysics 359, Pp. 117-129.

Said, R., Kenawy, A., 1956. Upper Cretaceous and Lower Tertiary foraminifera from northern Sinai, Egypt. Micropaleontology, 2 (2), Pp. 105-173.

Solakius, N., Pomoni-Papaioannou, F., Alexopouios, A., 1990. On the paleogeographic distribution of the Late Maastrichtian planktonic foraminiferal genus Kassabiana Salaj and Solakius, 1984. Acta Geologica Hispanica, 25 (4), Pp. 289-298.

Youssef, M., Taha, S., 2012. Biostratigraphy and Paleoecology of Paleocene/Eocene (P/E) interval of some geological sections in Central Egypt. Arabian Journal of Geosciences, Pp. 1-23.