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Representatives of the some diagnostic agglutinated for aminiferal genera of the Suborder Verneuilinina (*Plectina, Gaudryina, Siphogaudryina, Verneuilina*) in the Southern Tethys

Haidar Salim ANAN

Emeritus Professor of stratigraphy and micropaleontology, Al-Azhar University, Palestine.

Email profanan@gmail.com

Abstract

The present study deals with the paleontology, stratigraphy, paleogeography and paleoenvironment of eighteen small benthic foraminiferal species belong to four diagnostic agglutinated foraminiferal genera: *Plectina* Marsson, *Gaudryina* d'Orbigny, *Siphogaudryina* Cushman, and *Verneuilina* d'Orbigny, which recorded from some localities in the Southern Tethys (Egypt, Jordan, United Arab Emirates and Pakistan), and some of them are also recorded in other parts of the Southern Tethys (Tunisia, Iraq, Iran and Qatar), as well as also in the Northern Tethys (Spain, France and Italy). These species are: *Plectina emiratensis* Anan, *Gaudryina ameeri* Anan, G. *limbata* Said & Kenawy, *G. nitida* Haque, *G. speijeri* Anan, *G. textulariformis* Nakkady & Talaat, in Nakkady, *Siphogaudryina africana* (LeRoy), *S. daviesi* (Haque), *S. eleganta* (Haque), *S. elegantissima* (Said & Kenawy), *S. nammalensis* (Haque), *S. nekhlensis* (Said & Kenawy), *S. tellburmaensis* (Futyan), *S. strougoi* Anan, *Verneuilina aegyptiaca* Said & Kenawy, *Verneuilina karreri* Said & Kenawy *Verneuilina laevigata* Haque and *Verneuilina luxorensis* Nakkady. The paleontology, stratigraphy, paleoenvironment and paleogeographic distribution of them in the Tethys throughout the Late Cretaceous and Paleogene are presented and discussed.

Key words: Agglutinated foraminifera, paleogeography, paleoenvironment, Tethys

Introduction

An attempt has been made to study holotypes and hypotypes of as many of the described eighteen species of the four agglutinated genera of the Suborder Verneuilinina (*Plectina, Gaudryina, Siphogaudryina, Verneuilina*), as possible in connection with the original descriptions and figures. Nearly all the records for these agglutinated genera are common in the Maastrichtian-Early Paleogene, which originally erected in the Southern Tethys (Egypt, Jordan, UAE and Pakistan), and also recorded in Tunisia, Iraq, Iran and Qatar (Southern Tethys), and also Northern Tethys (Spain, France and Italy, Fig. 1). The intent of this study is to bring together many data scattered in the literature under a unifying theme, and to detect its paleontology, stratigraphy, paleoenvironment and paleogeographic distribution of them in the Tethys throughout the Late Cretaceous and Paleogene.

Taxonomy

The taxonomy of Kaminski (2014) is followed here. Eighteen diagnostic agglutinated benthic foraminiferal species (Plate 1) and revised stratigraphic ranges of them are also presented. The reference of the type species of the identified species is given. Some modern references have been added to complete descriptions, synonymies and the new taxonomic considerations.

Class Foraminiferea d'Orbigny, 1826
Subclass Monothalamana Pawlowski, Holzmann, Tyszka in Kaminski, 2014
Order Astrorhizida Lankester, 1885
Suborder Verneuilinina Mikhalevich & Kaminski, 2004
Superfamily Verneuilinacea Cushman, 1911
Family Prolixoplctidae Loeblich & Tappan, 1985
Genus *Plectina* Marsson, 1878
Type species *Gaudryina ruthenica* Reuss, 1851

***Plectina emiratensis* Anan, 2003**

(Pl. 1, fig. 1)

2003 *Plectina emiratensis* Anan, p. 534, fig. 4. 2. ●[illustrated species]
2011 *Plectina emiratensis* Anan, p. 53, pl. 1, fig. 5.
2016 *Plectina emiratensis* Anan, p. 356, fig. 3j.

Remarks: This species has short subconical test, subterminal and traverse elongate slit aperture on the apertural face of the last chambers and rather coarse-grained arenaceous wall. *P. emiratensis* was originally described from the Bartonian of Jabal Hafit (UAE). So far, it seems to be confined in the UAE.

Family **Reophacellidae** Mikhalevich & Kaminski, 2004
Subfamily Verneuilininae Cushman, 1911
Genus *Gaudryina* d'Orbigny, 1839
Type species *Gaudryina rugosa* d'Orbigny, 1840

***Gaudryina ameeri* Anan, 2012**

(Pl. 1, fig. 2)

2012a *Gaudryina ameeri* Anan, p. 63, pl. 1, fig. 7. ●
2016 *Gaudryina ameeri*; Anan, p. 357, fig. 3k.
2019 *Gaudryina ameeri*; Anan, p. 4, pl. 1, fig. 6.

Remarks: The front carinate rib is very distinct in this species, which exists along the pre-final chamber of the biserial stage as well as the whole triserial portion, while it exists in the final chamber of the biserial stage and extends to the triserial stage. Anan (2012a) proposed that this Early Eocene species most probably evolved from the Maastrichtian-Paleocene *G. pyramidata* Cushman, 1926. It is recorded from the Duwi section, Red Sea coast of Egypt. It is an excellent marker species for the Early Eocene in Egypt. It is, so far, an endemic to Egypt.

Gaudryina limbata Said & Kenawy, 1956

(Pl. 1, fig. 3)

1956 *Gaudryina limbata* Said & Kenawy, p. 123, pl. 1, fig. 23.
1990 *Gaudryina limbata*; Shahin, p. 506, fig. 6. 28.
1993a *Gaudryina limbata*; Anan, p. 314, pl. 1, fig. 6. ●
1993 *Gaudryina limbata*; Hewaidy & Al-Hitmi, p. 478, pl. 4, figs. 6, 7.
2002 *Gaudryina limbata*; Al-Hitmi, p. 45, pl. 1, fig. 10.
2003 *Gaudryina limbata*; Ali, p. 120, pl. 4, fig. 4.
2012b *Gaudryina limbata;* Anan, p. 20, pl. 1, fig. 3. ●
2014 *Gaudryina limbata*; Hewaidy et al., p. 21, pl. 4, fig. 5.
2016 *Gaudryina limbata;* Anan, p. 357, fig. 3m.

Remarks: This species was originally recorded from the Paleocene rocks of Sinai of Egypt, and later on in the Paleocene of UAE, but Maastrichtian of Qatar.

Gaudryina nitida Haque, 1956

(Pl. 1, fig. 4)

1956 *Gaudryina pyramidata* Cushman *nitida* Haque, p. 41, pl. 9, fig. 2. ●

Remarks: This Late Paleocene Pakistanian species has triserial chambers the early stage, and later biserial in transverse section, sharper edges, acute angles on one side having truncated periphery, wall arenaceous, aperture sutural a low opening in a semicircular of the inner margin of the last-formed chamber. It is, so far, an endemic to Pakistan.

Gaudryina speijeri Anan, 2012

(Pl. 1, fig. 5)

1994 *Gaudryina* cf. *ellisorae* Cushman; Speijer, p. 147, pl. 5, fig. 1. ●
2012a *Gaudryina speijeri* Anan, p. 66, pl. 1, fig. 10.
2016 *Gaudryina speijeri*; Anan, p. 357, fig. 3n.

Remarks: According to Speijer (1994) the carinate rib is very distinct in this Early Eocene species. It differs than the Later Cretaceous *Gaudryina* (*Pseudogaudryina*) *ellisorae* Cushman by its semiglobular last chamber with more circular aperture than the triangular last chamber with more elongate aperture. Moreover, the elongate and tapering final chamber with semicircular aperture at the apertural face in *Gaudryina ameeri* Anan differs from the semiglobular final chamber with circular aperture in the other *G. speijeri* Anan, but *G. speijeri* is longer and bigger test than *G. ameeri* Anan. Anan (2012a) proposed that the Early Eocene *G. speijeri* species most probably evolved from the Maastrichtian-Paleocene *G. pyramidata* Cushman (1926) in another direction of evolution than *G. ameeri*. *G. speijeri* is abundant in Sinai, Nile Valley and Red Sea coast of Egypt. It is an excellent marker species for the Early Eocene in Egypt. It is, so far, an endemic to Egypt.

Gaudryina textulariformis Nakkady & Talaat, in Nakkady, 1959

(Pl. 1, fig. 6)

1959 *Gaudryina textulariformis* Nakkady & Talaat; Nakkady, p. 457, pl. 6, fig. 3. ●
1990 *Gaudryina textulariformis;* Shahin, p. 506, fig. 6. 34.

Remarks: This Paleocene species is characterized by its small test, saucer-like shape of its last two chambers. It was recorded from Kharga Oasis of Egypt, and Paleocene-Early Eocene of Sinai, Egypt. It is, so far, an endemic to Egypt.

Genus *Siphogaudryina* Cushman, 1935
Type species *Gaudryina stephensoni* Cushman, 1928

***Siphogaudryina africana* (LeRoy, 1953)**

(Pl. 1, fig. 7)

1953 *Gaudryina africana* LeRoy, p. 30, pl. 1, figs. 7, 8. ●
1975 *Gaudryina cf. africana*; Proto Decima & de Biase, p. 91, pl. 1, fig. 13.
2000 *Pseudogaudryina ? africana*; Sztrákos, p. 157.
2008 *Siphogaudryina africana;* Anan, p. 361, pl. 1, fig. 1.
2016 *Siphogaudryina africana*; Anan, p. 357, fig. 3o.
2017 *Gaudryina africana*; Hewaidy et al., p. 83, pl. 2, fig. 19.
2020 *Siphogaudryina africana;* Anan, p. 3, pl. 1, fig. 1.

Remarks: This Egyptian Early-Middle Eocene species belongs to the genus *Siphogaudryina* due to its subterminal apertural face of the last-formed chamber, instead of inner marginal aperture of genus *Gaudryina* d'Orbigny. Anan (2012a) proposed that this species was evolved from the Paleocene *S. nekhlensis* (Said & Kenawy). It is an excellent marker species for the Early Eocene in Egypt. It was recorded originally from Egypt (Southern Tethys), and later from Italy and France (Northern Tethys).

***Siphogaudryina daviesi* (Haque, 1956)**

(Pl. 1, fig. 8)

1956 *Gaudryina daviesi* Haque, p. 37, pl. 31, fig. 14. ●
2019 *Siphogaudryina daviesi*; Anan, p. 31, pl. 1, fig. 3.
2020 *Siphogaudryina daviesi*; Anan, p. 3, pl. 1, fig. 4.

Remarks: This Pakistanian Early Eocene species belongs here to the genus *Siphogaudryina*. It is closely related to the Egyptian *S. elegantissima*, but differs in its more larger test in a younger stratigraphic level. *S. elegantissima* is considered as the ancestor of the descendent Early Eocene *S. daviesi* throughout changing to a larger test.

***Siphogaudryina elongata* (Haque, 1956)**

(Pl. 1, fig. 9)

1956 *Gaudryina laevigata* Franke var. *elongata* Haque, p. 35, pl. 9, fig. 5. ●
2019 *Siphogaudryina elongata*; Anan, p. 31, pl. 1, fig. 4.

Remarks: This Late Paleocene-Early Eocene Pakistanian species belongs here to the genus *Siphogaudryina* due to its subterminal aperture on the apertural face of the last formed chamber. It seems that the Jordanian *tellburmaensis* of Futyan (1976) is most related to Haque's *elongata* (Pakistan), but differs by its curved test. It is, so far, an endemic to Pakistan.

Siphogaudryina elegantissima (Said & Kenawy, 1956)

(Pl. 1, fig. 10)

1956 *Gaudryina elegantissima* Said & Kenawy, p. 123, pl. 1, fig. 21.
1993b *Gaudryina elegantissima*; Anan, p. 655, pl. 1, fig. 16.
1993 *Gaudryina elegantissima*; Hewaidy, Al-Hitmi, p. 478, pl. 4, figs. 4,5.
2012 *Gaudryina elegantissima*; Anan, p. 20, pl. 1, fig. 2. ●
2014 *Gaudryina elegantissima*; Hewaidy et al., p. 21, pl. 4, fig. 4.
2016 *Gaudryina elegantissima*; Anan, p. 357, fig. 3l.
2017 *Gaudryina elegantissima*; Hewaidy et al., p. 83, pl. 2, fig. 18.
2020 *Siphogaudryina elegantissima*; Anan, p. 3, pl. 1, fig. 3.

Remarks: This Paleocene Egyptian species belongs to the genus *Siphogaudryina* due to its subterminal aperture on the apertural face of the last formed chamber. It has a small elongated test, earliest portion small triserial, becoming eight distinct biserial chambers, very slightly inflated and gradually increasing in size as added, wall arenaceous smooth, aperture a circular opening at the base of the last chamber. It differs from *S. elongata* by its circular opening just at the base of the last chamber than the semicircular aperture, and in a higher level far the sutural position between the last two final chambers, and also younger stratigraphic level. It was recorded in Egypt, UAE and Qatar.

Siphogaudryina nammalensis (Haque, 1956)

(Pl. 1, fig. 11)

1956 *Gaudryina (Siphogaudryina) carinata* Franke *nammalensis* Haque, p. 40, pl. 3, fig. 2. ●

Remarks: This Late Paleocene species has a triserial part that make up on half of the entire test and not distinct from the later biserial part which are transversely triangular, wall arenaceous with fine coarsely finished, aperture rounded removed from the base of the last-formed chamber and more or less terminal. It is, so far, an endemic to Pakistan.

Siphogaudryina nekhlensis (Said & Kenawy, 1956)

(Pl. 1, fig. 12)

1956 *Gaudryina nekhlensis* Said & Kenawy, p. 124, pl. 1, fig. 24. ●
1994 *Gaudryina nekhlensis*; Speijer, p. 148, pl. 1, fig. 1.
2012b *Siphogaudryina nekhlensis*; Anan, p. 20, pl. 1, fig. 4.
2016 *Siphogaudryina nekhlensis*; Anan, p. 359, fig. 3p.

Remarks: This Late Paleocene Egyptian species was originally recorded from the of Nekhl section, Sinai of Egypt. It belongs to the genus *Siphogaudryina* due to its subterminal apertural face of last-formed chamber, instead of inner marginal aperture of genus *Gaudryina*. Anan (2012a) proposed that this species most probably the ancestor of the Early Eocene *S. africana*.

Siphogaudryina tellburmaensis (Futyan, 1976)

(Pl. 1, fig. 13)

1976 *Gaudryina soldadoensis tellburmaensis* Futyan, p. 522, pl. 81, fig. 1 (*non* fig. 2). ●
2016 *Gaudryina tellburmaensis*; Anan, p. 357, fig. 3ñ.
2020 *Siphogaudryina tellburmaensis*; Anan, p. 3, pl. 1, fig. 2.

Remarks: This Late Paleocene-Early Eocene *S. tellburmaensis* species belongs here to the genus *Siphogaudryina* due to its subterminal aperture on the apertural face of the last formed chamber. It has an elongated test with a pyramidal triserial early portion forming about one-third of the test, followed by inflated biserial chambers semicircular in cross-section separated by deeply depressed sutures. It was recorded from the Tell Burma section, south Jordan (the holotype is deposited in the British Museum Natural History, BMNH. P49102). The Jordanian *tellburmaensis* differs from the Pakistanian *S. elongata* of Haque (1956) by its curved test. It is, so far, an endemic to Jordan.

***Siphogaudryina strougoi* Anan, 2002**

(Pl. 1, fig. 14)

2002 *Siphogaudryina strougoi* Anan, p. 141, fig. 2.1. ●
2011 *Siphogaudryina strougoi;* Anan, p. 53, pl. 1, fig. 6.
2016 *Siphogaudryina strougoi;* Anan, p. 359, fig. 3q.

Remarks: This Late Paleocene Egyptian species is easily recognized by its large test, distinctive five longitudinal ridges along the test and raised transverse sutures. It differs from *S. nekhlensis* in having a larger test, three longitudinal ridges on the apertural view instead of two, and basal interiomarginal aperture instead of subterminal on the apertural face. It is, so far, an endemic to Egypt.

Genus *Verneuilina* d'Orbigny, 1839

Type species *Verneuilina tricarinata* d'Orbigny, 1840

***Verneuilina aegyptiaca* Said & Kenawy, 1956**

(Pl. 1, fig. 15)

1956 *Verneuilina aegyptiaca* Said & Kenawy, p. 122, pl. 1, fig. 16.
1970 *Verneuilina aegyptiaca*; Al-Omari, p. 49.
1993b *Verneuilina aegyptiaca*; Anan, p. 656, pl. 2, fig. 2. ●
1994 *Gaudryina pyramidata;* Speijer, p. 44, pl. 4, fig. 1.
2006 *Clavulinoides angularis*; Ortiz & Thomas, p. 102, pl. 1, fig. 1 (*non* figs. 2-6).
2016 *Gaudryina pyramidata;* VahdatiRad et al., p. 5, pl. 2, fig. 17.
2016 *Verneuilina aegyptiaca*; Anan, p. 359, fig. 3r.
2019 *Verneuilina aegyptiaca*; Bejaoui et al., p. 523, fig. 11.4.

Remarks: This species was originally recorded in the Maastrichtian-Paleocene of Sinai, Egypt, UAE, Tunisia, Iraq, Iran (S. Tethys). The figured Early-Middle Eocene Spanish specimen of Ortiz & Thomas (2006, pl.1, fig.1) from Fortuna section (N. Tethys) with its triangular test in cross section, is closely related to *V. aegyptiaca*.

***Verneuilina karreri* Said & Kenawy, 1956**

(Pl. 1, fig. 16)

1956 *Verneuilina karreri* Said & Kenawy, p. 122, pl. 1, fig. 17.
1993 *Valvoreussella karreri;* Hewaidy & Al-Hitmi, p. 481, pl. 6, figs. 7,8.
2005 *Verneuilina karreri*; Anan, p. 82, pl. 1, fig. 5. ●

2011 *Verneuilina karreri*; Anan, p. 16, pl. 1, fig. 8.
2012b *Verneuilina karreri*; Anan, p. 21, pl. 1, fig. 6.
2016 *Verneuilina karreri*; Anan, p. 359, fig. 3s.
2017 *Verneuilina karreri*; Hewaidy et al., p. 83, pl. 2, fig. 11.

Remarks: This species was recorded from the Maastrichtian-Paleocene of Sinai, Egypt (the holotype is deposited in the U.S.N.M. P3955), and later from Wadi Ed Dakhl, west Gulf of Suez (Egypt), and Iraq. It occurs in Maastrichtian-early Eocene of Qatar.

***Verneuilina laevigata* Haque, 1956**

(Pl. 1, fig. 17)

1956 *Verneuilina laevigata* Haque, p. 34, pl. 21, figs. 9, 12. ●

Remarks: This Late Paleocene species has triserial test in transverse section but with acute angles, wall coarsely arenaceous, aperture a wide semicircular opening at the base of the last-formed chamber. It differs from *V. aegyptiaca* Said & Kenawy (1956) and *V. paleocenica* (Tjalsma & Lohmann, 1983) by its acute periphery, more wide aperture opening and younger stratigraphic horizon than the Egyptian form. It is, so far, an endemic to Pakistan.

***Verneuilina luxorensis* Nakkady, 1950**

(Pl. 1, fig. 18)

1950 *Verneuilina luxorensis* Nakkady, p. 683, pl. 89, figs. 6,7.
2009 *Verneuilina luxorensis;* Anan, p. 34, pl. 1, fig. 2. ●
2016*Verneuilina luxorensis;* Anan, p. 359, fig. 3t.
2017 *Verneuilina luxorensis;* Hewaidy et al., p. 83, pl. 2, figs. 12,13.
2019 *Verneuilina luxorensis;* Anan, p. 4, pl. 1, fig. 5.

Remarks: This Early Eocene species has a pyramidal triserial test, compressed and much excavated on the three lateral faces, edges thin, chambers long and narrow, septal faces in the form of isosceles triangles, wall with much cement and a smoothly finished surface. *V. luxorensis* differs from the Maastrichtian-Paleocene *V. aegyptiaca* by its pyramidal test, which is more compressed and much excavated on three lateral thin edges. *V. luxorensis* (the holotype is deposited in the British Museum, Natural History) was originally recorded from the early Eocene of the Luxor section, Egypt. Anan (2010) considered it an excellent marker species to recognize the Early Eocene in Egypt.

Paleogeography

Eighteen small benthic foraminiferal species belong to four diagnostic agglutinated foraminiferal genera (*Plectina* Marsson, *Gaudryina* d'Orbigny, *Siphogaudryina* Cushman, *Verneuilina* d'Orbigny), were identified from some localities in the Southern

Tethys (Egypt, Jordan, UAE and Pakistan), and some of them are also recorded in other parts of the Southern Tethys (Tunisia, Iraq, Iran and Qatar), as well as also in the Northern Tethys (Spain, France and Italy). *Siphogaudryina africana* was recorded originally from Egypt, and later from Italy and France (Northern Tethys). *Gaudryina limbata* and *Siphogaudryina elegantissima* were recorded from Egypt, and later from UAE and Qatar. *Verneuilina aegyptiaca* has wide paleogeographic distribution in the Tethys: Tunisia, Egypt, UAE, Iraq, Iran (S. Tethys), and also Spain (N. Tethys). Five species *G. ameeri, G. textulariformis, G. speijeri, S. nekhlensis* and *S. strougoi* are endemic to Egypt. Five species of Haque: *G. nitida*, *S. daviesi*, *S. eleganta*, *S. nammalensis*, *V. laevigata* are endemic to Pakistan. One species *S. tellburmaensis* is endemic to Jordan.

Paleoenvironment

Miller et al. (1982) infer that certain hydrographic properties (low oxygen, high CO3, low pH, and thus more corrosive waters) favor the development of agglutinated assemblages. Speijer (1994) noted that the specimens from the deeper localities have smooth tests (i.e. *Gaudryina speijeri*), while shallow water specimens are coarser grained (i.e. *G. ameeri*). Anan (1995) noted that in the UAE, the Eocene time and surrounding areas had been located in the tropical and warm-temperate region based on many faunal environmental elements, and this interpretation is in accordance with the worldwide conclusions of Berggren (1978) and Moore et al. (1978). Ozsvárt (2007) noted that the diversity and composition of benthic foraminiferal assemblages is strongly controlled by water temperature and salinity of water mass, in shallow and deeper region on shelves, where changes in temperature and salinity might pass off rapidly. Hewaidy et al. (2014) noted that agglutinated *G. limbata* and *S. elegantissima* having cemented by calcareous material and interpreted as of shelf environment. Jones (2014) noted that the modern smaller agglutinating foraminifera occur in all marine environments, from marginal to deep, and some are tolerant of hyposalinity as well as normal marine salinity; and/or of hypoxia or dysoxia. They appear better able than their calcareous benthic counterparts to tolerate conditions of high fresh-water flux, and of high sediment and organic carbon flux, and associated lowered oxygen availability (also of lowered alkalinity, although this may be, at least in part, a preservational

phenomenon). Moreover, indeed, one family, the Verneuilinidae (e. g. genera: *Gaudryina*, *Siphogaudryina*, *Verneuilina*) is restricted to deep marine environments.

Summary and Conclusions

The present study deals with the recording of ten identified species of the four agglutinated foraminiferal genus *Plectina*, *Gaudryina*, *Siphogaudryina* and *Verneuilina* in four localities in the Southern Tethys (Egypt, Jordan, UAE and Pakistan). Eleven species from Egypt: *Gaudryina ameeri* Anan, G. *limbata* Said & Kenawy, *G. speijeri*, *G. textulariformis* Nakkady, Talaat, *Siphogaudryina africana* (LeRoy), *S. elegantissima* (Said & Kenawy), *S. nekhlensis* (Said & Kenawy), *S. strougoi* Anan, *Verneuilina aegyptiaca*, *V. karreri*, *V. luxorensis*. 5 species from Pakistan: *Gaudryina nitida* Haque, *Siphogaudryina daviesi* (Haque), *S. eleganta* (Haque), *S. nammalensis* (Haque) and *V. laevigata*. 1 species from Jordan: *Siphogaudryina tellburmaensis* (Futyan), 1 species from UAE: *Plectina emiratensis.* Some of these species are also recorded in other parts of the Southern Tethys (Tunisia, Iraq, Iran and Qatar), as well as some parts of the Northern Tethys (Spain, France and Italy). Haque (1956) noted that the Ranikot beds of Pakistan may be correlated to the Esna Shale (Paleocene-Early Eocene) of Egypt, and many foraminiferal forms which were recorded from Europe, America and Egypt are also recorded in the Laki formation of Pakistan. All of these identified species shows an affinity with the MTF middle-outer neritic environment (50-200 m) to outer neritic-upper bathyal (200-400 m). The existence of marked differences between the number of recorded benthic agglutinated foraminiferal species in respect with this study may be due to one or more of the following: a) less homogeneity in the generic or species concept between the different authors, b) differences in the paleoenvironmental conditions (depth, water temperature, salinity, nutrients, dissolved oxygen, land barrier, climate, etc..), c) deficiency of available literatures, d) significant episodes of tectonic activities in combinations with lowering sea-level in many stratigraphic horizons around the world during the Maastrichtian and Paleogene.

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References

Al-Hitmi, H. 2002. Foraminiferal biostratigraphy of the Upper Cretaceous succession in southwest Qatar, Arabian Gulf. Egyptian Journal of Paleontology, 2: 41-54.

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 der Ruhr-Universität Bochum vorgelegte Dissertation zur Erlangung des Grades eines: 1-197.

Al-Omari, F.S. 1970. Upper Cretaceous and lower Cenozoic foraminifera of three oil wells in northwestern Iraq. Missouri University of Science and Technology, Doctoral Dissertations 2207: 213p.

Anan, H.S. 1993a. Paleocene benthonic foraminifera of Jabal Malaqet, Al Ain region, United Arab Emirates. Al-Azhar Bulletin of Science, Al Azhar University, Cairo, 4/1: 293-320.

Anan, H.S. 1993b. Maastrichtian - Paleocene micropaleontology and biostratigraphy of Qarn El Barr section, Al Dhayd area, United Arab Emirates. Al-Azhar Bulletin of Science, Al-Azhar University, Cairo, 4/2: 639-670.

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

Anan, H.S. 2002. Two new benthic foraminiferal species from the Maastrichtian and Paleocene rocks of northern Egypt. Middle East Research Center, Ain Shams University, Earth Science Series, Cairo, 16: 141-144.

Anan, H.S. 2003. Three new species of benthic foraminifera from the Middle–Upper Eocene of Jabal Hafit, Al Ain area, United Arab Emirates. Neues Jahrbuch für Geologie und Paläontologie, Mh. 9: 529-536.

Anan, H.S. 2005. Agglutinated Middle-Upper Eocene foraminifera in Jabal Hafit, Al Ain area, United Arab Emirates. Revue de Paléobiologie, 24 (1): 17-27.

Anan, H.S. 2008. Maastrichtian-Paleogene LeRoy's benthic foraminiferal species from Egypt and Tethyan-Atlantic regions. Revue de Paléobiologie, 27/2: 357-376.

Anan, H.S. 2009. Paleontology, paleogeography, paleoenvironment and stratigraphical implications of the Nakkady's benthic foraminiferal fauna in Egypt and Tethys. Egyptian Journal of Paleontology, 9: 31-52.

Anan, H.S. 2010. Contribution to the Egyptian benthic foraminifera around the Paleocene/Eocene boundary in Egypt. Egyptian Journal of Paleontology, 10: 25-47.

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

Anan, H.S. 2012a: A lineage phylogeny from some Cretaceous-Tertiary agglutinated benthic foraminiferal species in Egypt and Tethys. Egyptian Journal of Paleontology, 12: 59-72.

Anan, H.S. 2012b. Paleontology, paleoenvironment and stratigraphic value of the Maastrichtian-Paleogene benthic foraminifera of Said, Kenawy (1956) from Egypt and Tethys. Egyptian Journal of Paleontology, 12: 17-30.

Anan, H.S. 2016. Early Paleogene agglutinated foraminifera from the Middle East (Egypt and Arabia) and its distribution in the Tethys. Spanish Journal of Paleontology, 31/2: 353-368.

Anan, H.S. 2019. Contribution to the paleontology, stratigraphy and paleobiogeography of some diagnostic Pakistanian Paleogene foraminifer in the Middle East. Earth Sciences Pakistan (ESP), 3/1: 29-34.

Anan, H.S. 2020. Taxonomic consideration and stratigraphic implication of the accelerated evolution of the Maastrichtian-Eocene transition of twenty benthic foraminiferal species in the Tethys. Earth Sciences Pakistan (ESP), 4 (1): 01-06.

Berggren, W.A. 1978. Recent advances in Cenozoic planktonic foraminiferal biostratigraphy, biochronology, and biogeography: Atlantic Ocean. Micropaleontology, 24/4: 337-370.

Bejaoui, A, Saïdi, E., Zaghbib-Turki, D. 2019. Small benthic foraminiferal biostratigraphy and paleoecology during the Campanian-Maastrichtian transition in north-western Tunisia. Turkish Journal of Earth Sciences, 28: 500-530.

Futyan, A.I. 1976. Late Mesozoic and Early Cainozoic benthonic foraminifera from Jordan. Palaeontology, 19/3: 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: 1-229.

Hewaidy, A.A. & Al-Hitmi, H. 1993. Cretaceous-Early Eocene foraminifera from Dukhan oil field, west Qatar, Arabian Gulf (A-Suborders Textulariina, Involutinina and Miliolina). Al-Azhar Bulletin of Science, 4/2: 469-494.

Hewaidy, A.A., Farouk S., Aly, H.A. & Bazeen, Y.A. 2014. Maastrichtian to Paleocene agglutinated foraminifera from the Dakhla Oasis, Western Desert, Egypt. Egyptian Journal Paleontology, 14: 1-38.

Hewaidy, A.A., Farouk, S. & EL-Balkiemy, A.F. 2017. Foraminiferal biostratigraphy, stages boundaries and paleoecology of the uppermost Maastrichtian-Lower Eocene succession at Esh El-Mellaha area, North Eastern Desert, Egypt. Journal of American Science, 13/5: 73-113.

Jones, R.W. 2014. Foraminifera and their applications. Cambridge University Press, First Publication: 1-391.

Kaminski, M.A. 2014. The year 2010 classification of the agglutinated foraminifera. Micropaleontology, 60 (1): 89-108.

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

Miller, K.G., Gradstein, F.M., Berggren, W.A. 1982. Late Cretaceous to Early Tertiary agglutinated benthic foraminifera in the Labrador Sea. Micropaleontology, 28 (1), 1-30.

Moore, Jr., T. C., van Andel, Tj. H., Sancetta, C. & Pisias, N. 1978. Cenozoic hiatuses in pelagic sediments. - Micropaleontology, 24/2: 113-138.

Morsi, A.M., Faris, M., Zalat, A. & Salem, R.F. 2008. Maastrichtian-Early Eocene Ostracodes from west-central Sinai, Egypt-taxonomy, biostratigraphy, paleoecology and paleobiogeography. Revue de Paléobiologie, 27/1: 159-189.

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

Nakkady, S.E. 1959. Biostratigraphy of the Um Elghanayem section, Egypt. Micropaleontology, 5/4: 453-472.

Ortiz, S. & Thomas E. 2006. Lower-middle Eocene benthic foraminifera from the Fortuna Section (Betic Cordillera, southeastern Spain). Micropaleontology, 52 (2): 97-150.

Ozsvärt, P. 2007. Middle and Late Eocene benthic foraminiferal fauna from the Hungarian Paleogene Basin: systematics and paleoecology. Geologica Pannonica, Special Publication 2: 1-129.

Proto Decima, F. & de Biase, R. 1975. Foraminiferi bentonici del Paleocene, dell' Eocene inferiore e medio. In: Braga, G. et al.: Foraminiferi bentonici del Paleocene ed Eocene della sezione di Possagno. Schweizerische Paläontologische Abhandlungen, 97: 87-98.

Said, R. & Kenawy, A. 1956. Upper Cretaceous and Lower Tertiary foraminifera from northern Sinai, Egypt. Micropaleontology, 2/2: 105-173.

Shahin, A. 1990. Late Cretaceous-Early Tertiary agglutinated benthic foraminifera and their paleoecology in the Gebel Ekma succession, southwestern Sinai, Egypt. Neues Jahrbuch für Geologie und Paläontologie, Mh., 8: 493-512.

Speijer, R.P. 1994. Extinction and recovery patterns in benthic foraminiferal paleocommunities across the Cretaceous/Paleogene and Paleocene/Eocene boundaries. Geologica Ultraiectina, Universiteit Utrecht, 124: 1-191.

Sztrákos, K. 2000. Eocene foraminifers in the Adour Basin (Aquitaine, France): biostratigraphy and taxonomy. Revue de Micropaléontologie, 43/1-2: 71-172.

Tjalsma, R.C. & Lohmann, G.P. 1983. Paleocene- Eocene bathyal and abyssal benthic foraminifera from the Atlantic Ocean. Micropaleontology, Special Publication, 4: 1-90.

VahdatiRad, M., Vahidinia M. & Sadeghi A. 2016. Early Eocene planktonic and benthic foraminifera from the Khangiran formation (northeast of Iran). Arab Journal of Geosciences, 9: 677.

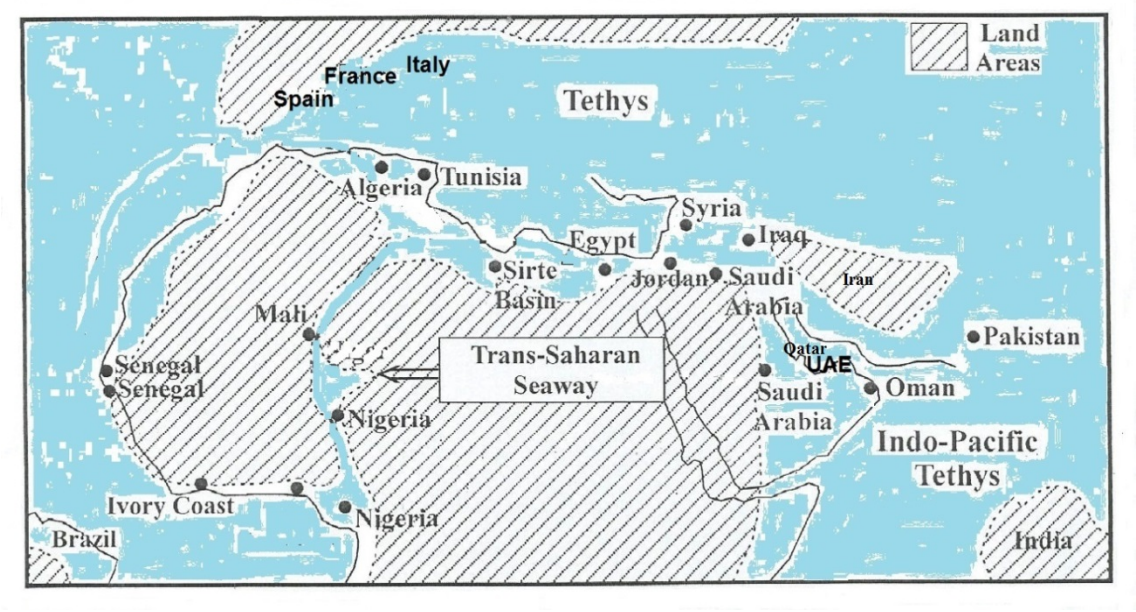

Fig. 1. Early Paleogene paleogeographic map of North Africa (including Tunisia and Egypt) and south Asia (including Jordan, UAE and Pakistan) in the Tethys (after Morsi et al., 2008).

Plate 1

1. *Plectina emiratensis* Anan, 2003 x 50, **2.** *Gaudryina ameeri* Anan, 2012 x 60, **3.** *G. limbata* Said & Kenawy, 1956 x 40, **4.** *G. nitida* Haque, 1956 x 45, **5.** *G. speijeri* Anan, 2012 x 60, **7.** *G. textulariformis* Nakkady & Talaat, in Nakkady, 1959 x 80, **5. 6.** *Siphogaudryina africana* (LeRoy, 1953) x 40, **7.** *S. daviesi* (Haque, 1956) x 70, **8.** *S. daviesi* (Haque, 1956) x 50, **9.** *S. eleganta* (Haque, 1956) x 50, **10.** *S. elegantissima* (Said & Kenawy, 1956) x 60, **11.** *S. nammalensis* (Haque, 1956) x 50, **12.** *S. nekhlensis* (Said & Kenawy, 1956) x 80, **13.** *S. tellburmaensis* (Futyan, 1976), x 60**, 14.** *S. strougoi* Anan, 2002**,** x 40, **15.** *Verneuilina aegyptiaca* Said & Kenawy, 1956 x 50, **16.** *V. karreri* Said & Kenawy, 1956 x 50, **17.** *V. laevigata* Haque, 1956 x 40, **18.** *V. luxorensis* Nakkady, 1950 x 50.

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