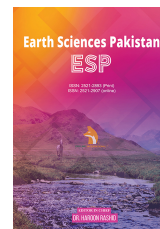


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## RESEARCH ARTICLE

## PALEOBIOGEOGRAPHY OF SOME EGYPTIAN AND PAKISTANIAN BENTHIC FORAMINIFERAL SPECIES IN THE NORTHERN TETHYS

Haidar Salim Anan

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

\*Corresponding Author Email: [profanan@gmail.com](mailto:profanan@gmail.com)

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## ABSTRACT

Twenty-one benthic foraminiferal species were originally erected from the Southern Tethys, 13 species from Egypt, and 8 species from Pakistan. Some of these species were recorded from different localities in the Northern Tethys: France, Spain, Italy, North Atlantic, Slovenia and Gulf of Biscay. *Textularia crookshanki*, *Trifarina esnaensis* and *Cibicoides libycus* in France and North Atlantic, *Orthokarstenia nakkadyi* and *Cibicoides pseudoacutus* in France and Spain, *Eponides lotus* in Italy and Gulf of Biscay, *Siphogaudryina africana* in France and Italy, *Asterigerina brenci* in Spain and Slovenia. Another 9 Southern Tethyan foraminiferal species were recorded in France (*Spiroplectinella esnaensis*, *Astacolus vomeriformis*, *Vaginulinopsis nammalensis*, *Reussella johnstoni*, *Angulogavelinella abudurbensis*, *Cibicoides nammalensis*, *Planulina sinaensis*, *Asterigerina cunifformis*, *Elphidiella africana*), 2 species in Spain (*Verneulina aegyptiaca*, *Coleites galeebi*), and one species in Italy (*Haplophragmoides desertorum*), and Hungary (*Bathysiphon saidi*).

## KEYWORDS

Paleogeography, foraminifera, Tethys, Egypt, Pakistan, North Atlantic, Europe.

## 1. INTRODUCTION

At the mid of twentieth century, beside the earlier American and European assemblages (Northern Tethys), some local authors, and others, from Africa and Asia at the Southern Tethys were started to introduced a new benthic foraminiferal species from their own countries which added another new taxa, particularly from Egypt: Schwager (1883), Nakkady (1950), LeRoy (1953), Ansary (1955), Said & Kenawy (1956), Anan (1994, 2009) and from Pakistan: Haque (1956, 1960) (Fig. 1). The intent of this study is fourfold to throw light on some erected benthic foraminiferal assemblage in some Southern Tethyan localities, particularly from Egypt (13 new species) and also Pakistan (8 new species), and the existence of these species in different localities of the Northern Tethys (Spain, Gulf of Biscay, France, Italy, Hungary, Slovenia, North Atlantic) as well as in the Southern Tethyan localities (Jordan, Iraq, UAE, Libya, Tunisia, Mali, Nigeria) (Figs. 2, 3).

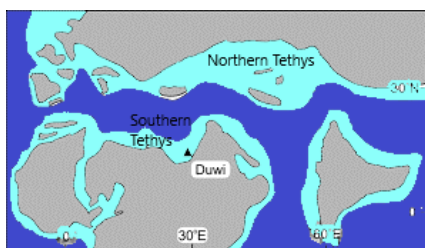


Figure 1: Paleogene Northern and Southern Tethys, and also the detection of Duwi section in Egypt (modified after Anan, 2019a).

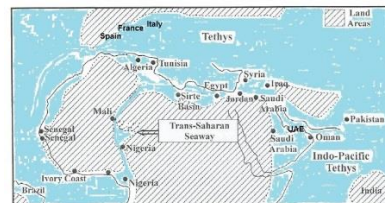


Figure 2: Paleogene paleogeographic map of West Asia and North Africa (Southern Tethys) and South Europe (Northern Tethys) showing an open Tethys between them (modified after Morsi et al., 2008).

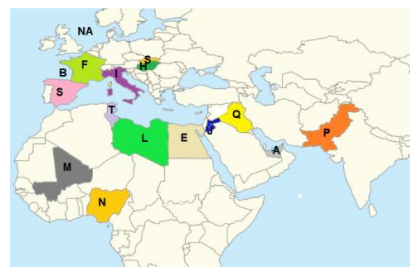


Figure 3: The paleogeographic distribution of the benthic foraminiferal species from the Southern Tethyan: P=Pakistan, A=UAE, Q=Iraq, J=Jordan, E=Egypt, L=Libya, T=Tunisia, M=Mali, N=Nigeria, which also recorded in different localities of European Northern Tethys: S=Spain, B=Gulf of Biscay, F=France, I=Italy, H=Hungary, S=Slovenia, NA=North Atlantic.

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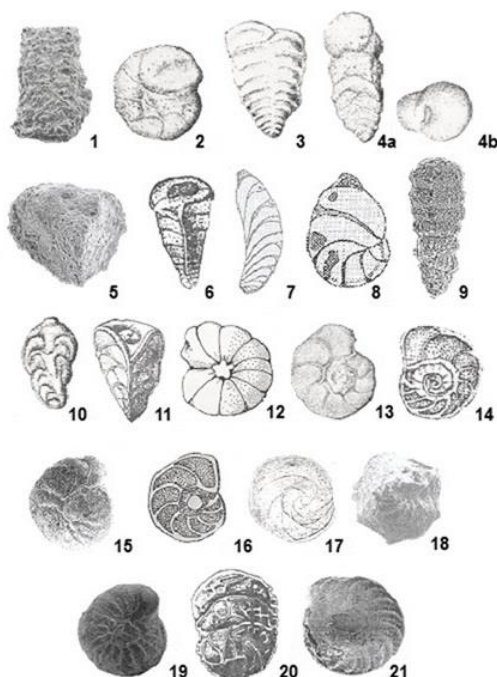
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## 2. PREVIOUS STUDIES

Most of the identified benthic foraminiferal species were erected originally earlier in nineteenth century or later by European and American authors from different localities in their own countries, and after that are used in all over the world throughout the open Tethys in the Late Cretaceous-Paleogene times, i.e. taxa of USA of Plummer (1927) by Anan (2017). Recently, some studies were attempted to present the paleogeography of some diagnostic Egyptian and Pakistanian foraminifera in the Middle East (Anan, 2019a, b; 2020). In this study, another attempt is presented to record the existence of some Egyptian and Pakistanian foraminiferal species in different localities of the Northern Tethys (Gulf of Biscay, Spain, France, Italy, Hungary, Slovenia, North Atlantic).

## 3. TAXONOMY

The taxonomy of Loeblich & Tappan (1988) is followed in this study. The twenty one identified species from the Southern Tethys and recorded in the Northern Tethys are illustrated in Plate 1.



**Plate 1:** 1. *Bathysiphon saidi* (Anan) x30. 2. *Haplophragmoides desertorum* LeRoy x50. 3. *Spiroplectinella esnaensis* (LeRoy) x50. 4a, b. *Siphogaudryina africana* (LeRoy) x30, a. side view, b. apertural view. 5. *Verneuilina aegyptiaca* Said & Kenawy x60. 6. *Textularia crookshanki* Haque x40. 7. *Astacolus vomeriformis* (Haque) x20. 8. *Vaginulinopsis nammalensis* (Haque) x40. 9. *Orthokarstenia nakkadyi* Anan x30. 10. *Trifarina esnaensis* LeRoy x50. 11. *Reussella johnstoni* Haque x65. 12. *Eponides lotus* (Schwager) x50. 13. *Cibicoides libycus* (LeRoy) x25. 14. *C. nammalensis* (Haque) x95. 15. *C. pseudoacutus* (Nakkady) x40. 16. *Planulina synaensis* Ansary x70. 17. *Asterigerinata cuniformis* Haque x100. 18. *Asterigerina brenci* Haque x130. 19. *Angulogavelinella abudurbensis* (Nakkady) x100. 20. *Coleites galeebi* Haque x50. 21. *Elphidiella africana* (LeRoy) x50.

Order Foraminiferida Eichwald, 1830  
Suborder Textulariina Delage & Hérouard, 1896  
Superfamily Astrorhizacea Brady, 1881  
Family Bathysiphonidae Avnimelech, 1952  
Genus *Bathysiphon* Sars, 1872  
Type species *Bathysiphon filiformis* Sars, 1872

*Bathysiphon saidi* (Anan, 1994) - (Pl. 1, fig. 1)  
1994 *Rhabdammina saidi* Anan, p. 218, fi g. 8. 1.  
2005 *Bathysiphon saidi* (Anan) - Anan, p. 19, pl. 1, fig. 2. • [illustrated species]  
2007 *Bathysiphon saidi* (Anan) - Ozsvárt, p. 29, pl. 1, figs 2, 3.  
2016 *Bathysiphon saidi* (Anan) - Anan, p. 355, fig. 3b.

Remarks: The wide stratigraphic range of the Triassic-Holocene genus

*Bathysiphon* differs from the Holocene *Rhabdammina* Sars by its straight unbranched elongated tube. This species has an elongated test and the wall is constructed of firmly cemented coarse sand grains with a rough exterior. It was originally described from the Bartonian-Priabonian (Middle-Late Eocene) of Fayoum area and Sinai, Egypt, and Jabal Hafit, UAE (Southern Tethys) and later from Hungary (Northern Tethys).

Superfamily Lituolacea de Blainville, 1827  
Family Haplophragmoididae Maync, 1952  
Genus *Haplophragmoides* Cushman, 1910  
Type species *Nonionina canariensis* d'Orbigny, 1839

*Haplophragmoides desertorum* LeRoy, 1953 - (Pl. 1, fig. 2) 1953  
*Haplophragmoides desertorum* LeRoy, p. 36, pl. 1, figs. 21, 22. • 1975  
*Haplophragmoides desertorum* LeRoy - Braga & Grünig, p. 102.

Remarks: This Early Eocene species has close-coiled planispiral test with 9-11 chambers, curved and depressed sutures, rounded periphery, smooth finely arenaceous wall. It was recorded in Egypt (S. Tethys) and Italy (N. Tethys).

Superfamily Spiroplectamminacea Cushman, 1927  
Family Spiroplectamminidae Cushman, 1927  
Subfamily Spiroplectammininae Cushman, 1927  
Genus *Spiroplectinella* Kisel'man, 1972  
Type species *Spiroplecta wrightii* Silvestri, 1903

***Spiroplectinella esnaensis* (LeRoy, 1953) - (Pl. 1, fig. 3)**  
1953 *Spiroplectammina esnaensis* LeRoy, p. 50, pl. 1, figs. 11, 12.  
1976 *Spiroplectinella esnaensis* (LeRoy) - Aubert & Berggren, p. 409, pl. 1, fi g. 6.  
2005 *Spiroplectinella esnaensis* (LeRoy) - Sztrákos, p. 184, pl. 12, fig. 16.  
2007 *Spiroplectinella esnaensis* (LeRoy) - Alegret & Ortiz, p. 437, pl. 1, fig. 6. •  
2016 *Spiroplectinella esnaensis* (LeRoy) - Anan, p. 356, fig. 3h.

Remarks: This Paleocene-early Eocene species is characterized by its raised sutures and a broad apertural face. It was recorded from the Paleocene of Egypt and Tunisia (S. Tethys), and later from France (N. Tethys).

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

***Siphogaudryina africana* (LeRoy, 1953) - (Pl. 1, fig. 4a, b)**  
1953 *Gaudryina africana* LeRoy, p. 30, pl. 2, figs. 7, 8. •  
1975 *Gaudryina* cf. *africana* LeRoy - Proto Decima & De Biase, p. 91, pl. 1, fig. 13.  
2000 *Pseudogaudryina* ? *africana* (LeRoy) - Sztrákos, p. 136.  
2008 *Siphogaudryina africana* (LeRoy) - Anan, p. 361, pl. 1, fig. 1.  
2020 *Siphogaudryina africana* (LeRoy) - Anan, p. 3, pl. 1, fig. 1.

Remarks: This Early Eocene species belongs to the genus *Siphogaudryina* due to its subterminal apertural in the apertural face of the last-formed chamber, instead of the inner marginal aperture of the genus *Gaudryina* d'Orbigny. It has a large elongated robust test, tapering initial triserial portion and greatest breadth at the beginning of the biserial stage, with distinctive four longitudinal not acute edges running nearly parallel to the periphery, two out of them appear on the apertural view along the test, sutures indistinct and depressed. It was originally described from Maqfi section, Western Desert of Egypt (S. Tethys) and later in Italy and France (N. Tethys).

Genus *Verneuilina* d'Orbigny, 1839  
Type species *Verneuilina tricarinata* d'Orbigny, 1839

***Verneuilina aegyptiaca* Said & Kenawy, 1956 - (Pl. 1, fig. 5)**  
1956 *Verneuilina aegyptiaca* Said & Kenawy, p. 122, pl. 1, fi g. 16.  
1970 *Verneuilina aegyptiaca* Said & Kenawy - Al-Omari, p. 49.  
1993 *Verneuilina aegyptiaca* Said & Kenawy - Anan, p. 656, pl. 2, fi g. 2.  
1994 *Gaudryina pyramidata* Cushman - Speijer, p. 44, pl. 4, fig. 1.  
2006 *Clavulinoides angularis* (d'Orbigny) - Ortiz & Thomas, p.102, pl.1, fig.1 (non figs. 2-5). •  
2019 *Verneuilina aegyptiaca* Said & Kenawy - Bejaoui et al., 523, fig. 11. 4.

Remarks: This species was originally recorded in the Maastrichtian-Paleocene of Sinai, Egypt, UAE, Tunisia, Iraq (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*.

Superfamily Textulariacea Ehrenberg, 1838  
Family Textulariidae Ehrenberg, 1838  
Subfamily Textulariinae Ehrenberg, 1838  
Genus *Textularia* Defrance, 1824  
Type species *Textularia sagittula* Defrance, 1824

*Textularia crookshanki* Haque, 1956 - (Pl. 1, fig. 6)  
1956 *Textularia crookshanki* Haque, p. 32, pl. 9, fig. 9<sub>2</sub> ●  
2000 *Textularia crookshanki* Haque - Sztrákos, p. 157.  
2005 *Textularia crookshanki* Haque - Sztrákos, p. 184.  
2007 *Textularia crookshanki* Haque - Ozsvárt, p. 35, pl. 1, fig. 20.

Remarks: This Early Eocene species is characterized by its biserial test slightly flaring towards apertural end, chambers two times as long as with rapidly increasing in size, horn-like in outline, biconvex mildly compressed, parallelogram-like in cross-section, periphery acute, sutures mildly depressed, gently curved towards apertural end, wall finely agglutinated, aperture interiomarginal wide slit. It was recorded from Pakistan (S. Tethys), and later from France and Hungary (N. Tethys).

Suborder Lagenina Delage & Hérouard, 1896  
Superfamily Nodosariacea Ehrenberg, 1838  
Family Vaginulinidae Reuss, 1860  
Subfamily Marginulininae Wedekind, 1937  
Genus *Astacolus* de Montfort, 1808  
Type species *Astacolus crepidulatus* de Montfort, 1808

***Astacolus vomeriformis* (Haque, 1956) - (Pl. 1, fig. 7)**  
1956 *Dentalina* (?) *vomeriformis* Haque, p. 78, pl. 23, fig. 9.  
2005 *Astacolus vomeriformis* (Haque) - Sztrákos, p. 186, pl. 14, fig. 16. ●

Remarks: This Early Eocene species has elongate test with nearly parallel sides, early stage constitutes minor coiled portion, about 10 chambers uniserial stage, sutures curved, acute outer periphery, wall smooth, aperture terminal. It was recorded from Pakistan (S. Tethys), and later from France (N. Tethys).

Genus *Vaginulinopsis* Silvestri, 1904  
Type species *Vaginulina soluta* Silvestri var. *carinata* Silvestri 1898

***Vaginulinopsis nammalensis* (Haque, 1956) - (Pl. 1, fig. 8)**  
1956 *Marginulina glabra* d'Orbigny *nammalensis* var. Haque, p.74, pl.11, figs.1-4.  
2005 *Vaginulinopsis nammalensis* (Haque) - Sztrákos, p. 186, pl. 14, fig. 28. ●

Remarks: This Early Eocene species has planispirally enrolled involute early stage, later uncoiled laterally compressed and ovate in section, sutures curved, smooth surface. It was recorded from Pakistan (S. Tethys), and later France (N. Tethys).

Suborder Rotaliina Delage and Hérouard, 1896  
Superfamily Buliminacea Jones, 1875  
Family Siphogenerenoididae Saidova, 1981  
Subfamily Siphogenerenoidinae Saidova, 1981  
Genus *Orthokarstenia* Dietrich, 1935  
Type species *Orthoceria ewaldi* Karsten, 1858

***Orthokarstenia nakkadyi* Anan, 2009 - (Pl. 1, fig. 9)**  
1998 Transitional form between *Orthokarstenia higazyi* (Nakkady) and *O. eleganta* (Plummer) - Anan, p. 368, fig. 3. 7.  
2000 *Rectuvigerina clavata* (Franzenau) - Sztrákos, p. 106, pl. 13, fig. 2. ●  
2006 *Siphogenerinoides eleganta* (Plummer) - Ortiz & Thomas, p. 132, pl. 11, fig. 4.  
2007 *Siphogenerinoides eleganta* (Plummer) - Alegret & Ortiz, p. 441, pl. 2, fig. 43.  
2009 *Orthokarstenia nakkadyi* Anan, p. 37, pl. 1, fig. 7.  
2019c *Orthokarstenia nakkadyi* Anan - Anan, p. 264, pl. 2, fig. 58.

Remarks: The distinguished character of *O. nakkadyi* is the longitudinal costae on the lower part of the test (tri- and biserial stage), but without costae ornamentation on the upper part of the test (the uniserial stage) has an illness treatment by many authors as Plummer's *eleganta* (with smooth surface, without longitudinal costae). The *O. nakkadyi* was originally recorded from the Middle Paleocene (Selandian, P4a Zone) of Duwi section, Egypt, but Paleocene-Early Eocene of the Esna Shale of

Dababiya section, south of Luxor by Alegret & Ortiz (2007). On the other hand, this species *O. nakkadyi*, was recorded around the Ypresian/Lutetian transition in France (Sztrákos, 2000) and Spain (Ortiz & Thomas, 2006). For that, this species has wide geographic distribution in Egypt and Tunisia (S. Tethys) and also France and Spain (N. Tethys). Accordingly, the stratigraphic range of *O. nakkadyi* is Middle Paleocene to Middle Eocene.

Superfamily Buliminacea Jones, 1875  
Family Uvigerinidae Haeckel, 1894  
Subfamily Angulogerininae Galloway, 1933  
Genus *Trifarina* Cushman, 1923  
Type species *Trifarina bradyi* Cushman, 1923

***Trifarina esnaensis* LeRoy, 1953 - (Pl. 1, fig. 10)**  
**1953 *Trifarina esnaensis* LeRoy, p. 52, pl. 8, figs. 5, 6. ●**

1974a *Trifarina esnaensis* LeRoy - Berggren, p. 438, pl. 1, fig. 6.  
1988 *Trifarina esnaensis* LeRoy - Keller, p. 161, pl. 3, figs. 15, 16.  
1993 *Trifarina esnaensis* LeRoy - Anan, p. 659, pl. 3, fig. 9.  
2000 *Trifarina esnaensis* LeRoy - Sztrákos, p. 166.  
2003 *Trifarina esnaensis* LeRoy - Culver, 102 p.192, fig.10.  
2019c *Trifarina esnaensis* LeRoy - Anan, p. 265, pl. 2, fig. 66.

Remarks: This Paleocene-Eocene species has small test, about twice as long as broad, triangular in cross section. It was recorded from Egypt, UAE and Tunisia (S. Tethys), France and North Atlantic (N. Tethys).

Family Reussellidae Cushman, 1933  
Genus *Reussella* Galloway, 1933  
Type species *Verneuilina spinulosa* Reuss, 1850

***Reussella johnstoni* Haque, 1960 - (Pl. 1, fig. 11)**  
1960 *Reussella johnstoni* Haque, p. 27, pl. 5, fig. 6. ●  
2000 *Reussella johnstoni* Haque - Sztrákos, p. 166.

Remarks: This species is characterized by its pyramidal triserial test, chambers enlarging gradually, sutures curved and oblique. It was recorded from Pakistan (S. Tethys) and France (N. Tethys).

Family Eponididae Hofker, 1951  
Subfamily Eponidinae Hofker, 1951  
Genus *Eponides* de Montfort, 1808  
Type species *Nautilus repandus* Fichtel & Moll, 1798

***Eponides lotus* (Schwager, 1883) - (Pl. 1, fig. 12)**  
1883 *Pulvinulina lota* Schwager, p. 132, pl. 28, fig. 9.  
1953 *Eponides lotus* (Schwager) - LeRoy, p. 30, pl. 11, figs. 4, 8, 9.  
1956 *Eponides lotus* (Schwager) - Haque, p. 146, pl. 7, fig. 6.  
1975 *Eponides lotus* (Schwager) - Proto Decima & D Biase, p. 75, pl. 3, fig. 17. ●  
1976 *Eponides lotus* (Schwager) - Salaj, p. 157, pl. 10, fig. 2.  
1979 *Eponides lotus* (Schwager) - Schnitker, p. 396, pl. 4, figs. 10-12.

Remarks: This Eocene species is characterized by its strongly convex dorsal side, 6-8 chambers in last-formed whorl, aperture a low arched slit at base of the last chamber. It was recorded from Egypt, Tunisia and Pakistan (S. Tethys), as well as Italy and Gulf of Biscay (N. Tethys).

Superfamily Discorbinellacea Sigal, 1956  
Family Parrelloididae Hofker, 1951  
Genus *Cibicoides* Thalmann, 1939  
Type species *Truncatolina mundula* Brady, Parker & Jones, 1890

***Cibicoides libycus* (LeRoy, 1953) - (Pl. 1, fig. 13)**  
1953 *Cibicides libycus* LeRoy, p. 24, pl. 5, figs. 1-3. ●  
1980 *Heterolepa libyca* (LeRoy) - Saperson & Janal, p. 404, pl. 2, fig. 4.  
2005 *Heterolepa libyca* (LeRoy) - Sztrákos, p. 189, pl. 9, fig. 9.  
2008 *Cibicoides libycus* (LeRoy) - Anan, p. 365, pl. 1, fig. 8.  
2019c *Cibicoides libycus* (LeRoy) - Anan, p. 268, pl. 3, fig. 81.

Remarks: According to Loeblich & Tappan (1988), the genus *Cibicoides* Thalmann differs from the genus *Heterolepa* has a slit-like aperture extending about half of the distance to umbilicus and extending short distance across periphery on dorsal side, but without biumbonate test. *H. libyca* differs from the genus *Cibicoides* Thalmann by its biconvexity among other characters. Both *C. alleni* and *C. libycus* have conspicuous biumbonate test, and a low interiomarginal equatorial arch aperture. The Paleocene-early Eocene *C. libycus* is characterized by its depressed sutures in both sides than elevated and taper sutures in the dorsal side and slightly in the ventral side in *C. alleni* (Plummer). *C. libycus* was recorded from Egypt, Libya, Tunisia (S. Tethys) and later from France, Turkmenia, North



Atlantic (N. Tethys).

***Cibicoides nammalensis* Haque, 1956 - (Pl. 1, fig. 14)**

- 1956 *Cibicoides nammalensis* (Haque), p. 206, pl. 20, fig. 10. ●  
 2005 *Cibicoides nammalensis* (Haque) - Sztrákos, p. 226, pl. 15, fig. 35.  
 2019a *Cibicoides nammalensis* (Haque) - Anan, p. 32, pl. 2, fig. 14a-c.

Remarks: This Early Eocene species has biconvex test with keel, about 10 chambers in the ventral side with umbo. It was recorded from Pakistan (S. Tethys) and France (N. Tethys).

***Cibicoides pseudoacutus* (Nakkady, 1950) - (Pl. 1, fig. 15)**

- 1950 *Anomalina pseudoacuta* Nakkady, p. 691, pl. 90, figs. 29-32.  
 1994 *Cibicoides pseudoacutus* (Nakkady) - Speijer, p. 54, pl. 7, fig. 6.  
 2002 *Cibicoides pseudoacutus* (Nakkady) - Galeotti & Coccioni, p. 198, fig. 1.  
 2004 *Cibicoides pseudoacutus* (Nakkady) - Alegret et al., p. 38, fig. 8, fig. 5.  
 2005 *Cibicoides pseudoacutus* (Nakkady) - Guasti et al., p. 4, pl. 1, fig. 14.  
 2005 *Gavelinella pseudoacuta* (Nakkady) - Sztrákos, p. 214, pl. 9, fig. 14. ●  
 2007 *Cibicoides pseudoacutus* (Nakkady) - Alegret & Ortiz, p. 440, pl. 2, fig. 2.

Remarks: According to Loeblich & Tappan (1988), the genus *Cibicoides* Thalmann differs from the genus *Gavelinella* Brotzen by its biconvex, biumbonate test and angular periphery than rounded in the other. The Maastrichtian-Early Eocene *C. pseudoacutus* is characterized by its fine beads, which surround a thick irregular spiral of translucent shell substance on ventral side. This species was recorded from Egypt, and later from Tunisia (S. Tethys) and France (N. Tethys).

Superfamily Planorbulinae Schwager, 1877

Family Planulinidae Bermúdez, 1952

Genus *Planulina* d'Orbigny, 1826

Type species *Operculina* ? *umbonifera* Howchin & Parr, 1938

***Planulina synaensis* Ansary, 1955 - (Pl. 1, fig. 16)**

- 1955 *Planulina synaensis* Ansary, p. 129, pl. 4, fig. 14. ●  
 2000 *Planulina synaensis* Ansary - Sztrákos, p. 169.  
 2005 *Cibicides synaensis* (Ansary) - Basha, p. 205.  
 2013 *Planulina synaensis* Ansary - Anan, p. 54, pl. 1, figs. 14-17.

Remarks: This Eocene species is differentiated from other *Planulina* species by its raised boss biumbonate test. It was recorded from Egypt and Jordan (S. Tethys), and also from the Pyrenean trough of France (N. Tethys).

Superfamily Asterigerinacea d'Orbigny, 1839

Family Asterigerinatidae Reiss, 1963

Genus *Asterigerinata* Bermúdez, 1949

Type species *Asterigerinata dominicana* Bermúdez, 1949

***Asterigerinata cunifformis* Haque, 1956 - (Pl. 1, fig. 17)**

- 1956 *Asterigerinata cunifformis* Haque, p. 165, pl. 22, fig. 5. ●  
 2000 *Asterigerinata* cf. *cunifformis* Haque - Sztrákos, p. 169.

Remarks: This Early Eocene species has discoidal inequally biconvex test with more elevated dorsal side, 6-8 chambers visible in the last whorl with peripheral keel. It was recorded from Pakistan (S. Tethys) and also from France (N. Tethys).

Superfamily Asterigerinacea d'Orbigny, 1839

Family Asterigerinidae d'Orbigny, 1839

Genus *Asterigerina* d'Orbigny, 1839

Type species *Asterigerina carinata* d'Orbigny, 1839

***Asterigerina brencei* Haque, 1960 - (Pl. 1, fig. 18)**

- 1960 *Asterigerina brencei* Haque, p. 33, pl. 2, fig. 3.  
 2006 *Asterigerina brencei* Haque - Ortiz & Thomas, p. 112, Pl. 4, fig. 4.  
 2006 *Asterigerina brencei* Haque - Cimerman et al., p. 36, pl. 10, figs. 1-2. ●

Remarks: This Eocene species was recorded from Pakistan (S. Tethys) and also from Spain and Slovenia (N. Tethys).

Superfamily Chilostomellacea Bandy, 1881

Family Gavelinellidae Hofker, 1956

Subfamily Gavelinellinae Hofker, 1956

Genus *Angulogavelinella* Hofker, 1957

Type species *Discorbina gracilis* Marsson, 1878

***Angulogavelinella abudurbensis* (Nakkady, 1950) - (Pl. 1, fig. 19)**

- 1950 *Cibicides abudurbensis* Nakkady, p. 691, pl. 90, figs. 35-38.  
 1993 *Cibicoides abudurbensis* (Nakkady) - Anan, p. 663, pl. 3, fig. 13.  
 1994 *Cibicoides abudurbensis* (Nakkady) - Speijer, p. 54, pl. 4, fig. 6. ●  
 2003 *Angulogavelinella abudurbensis* (Nakkady) - El Dawy & Hewaidy, p. 79, pl. 1, figs. 4-6.  
 2005 *Gavelinella abudurbensis* (Nakkady) - Sztrákos, p. 230, pl. 17, fig. 11.

Remarks: The Maastrichtian-Early Eocene *A. abudurbensis* was originally recorded by Nakkady (1950) from Egypt, and later from Tunisia, UAE (S. Tethys) and France (N. Tethys).

Superfamily Chilostomellacea Brady, 1881

Family Coleitidae Loeblich & Tappan, 1984

Genus *Coleites* Plummer, 1934

Type species *Pulvinulina reticulosa* Plummer, 1927

***Coleites galeebi* Haque 1960 - (Pl. 1, fig. 20)**

- 1960 *Coleites galeebi* Haque, p. 32, pl. 5, fig. 8. ●  
 2007 *Coleites galeebi* Haque - Ortiz & Thomas, p. 117, pl. 7, figs. 1-2.

Remarks: Test trochospiral equally biconvex, surface chambers obscured by ornamentation, about six in the final whorl separated by indistinct curved sutures, wall calcareous strongly ornamented by a coarse reticulation obscuring the entire surface. This Eocene species was recorded from Pakistan (S. Tethys) and also from Spain (N. Tethys).

Family Elphidiidae Galloway, 1933

Subfamily Elphidiinae Galloway, 1933

Genus *Elphidiella* Cushman, 1936

Type species *Polystomella arctica* Parker & Jones in Brady, 1864

***Elphidiella africana* (LeRoy, 1953) - (Pl. 1, fig. 21)**

- 1953 *Elphidium africanum* LeRoy, p. 28, pl. 3, figs. 11, 12.  
 1974b *Elphidiella africana* (LeRoy) - Berggren, p. 459.  
 1998 *Elphidiella africana* (LeRoy) - Haynes & Nwabufo-Ene, p. 53.  
 2000 *Elphidium* cf. *africanum* LeRoy - Sztrákos, p. 172, pl. 19, fig. 1. ●  
 2008 *Elphidiella africana* (LeRoy) - Anan, p. 367.

Remarks: This Eocene species belongs to the genus *Elphidiella* as treated previously by Berggren (1974) and Haynes & Nwabufo-Ene (1998). It was recorded from Egypt, Libya, Mali and Nigeria at central Africa (S. Tethys), and also from France (N. Tethys).

#### 4. PALEO GEOGRAPHY

The paleogeographic maps (partly or regionally) of some authors, i. e. Mintz (1981), Rosenbaum et al. (2002) 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 Maastrichtian-Paleogene time. Haq & Aubry (1978) noted that the North Africa and Middle East formed important parts of the Tethyan link between the Atlantic and Pacific Oceans during Paleogene. Solakius et al (1990) noted that the ancestral Tethys is connected with the ancestral Atlantic and Indian Oceans via Mediterranean Sea. Anan (1995) concluded that the Tethyan realm during the middle-late Eocene extends to the southeast and connected with the Indo-Pacific realm via seaway separating Arabia from Iran-India region. Haynes and Nwabufo-Ene (1998) suggested wider Tethyan connections, as far as the Carpathian and Pakistan. Rögl (1999) noted that by the end of the Eocene the Tethys Ocean had already vanished, a new Indian Ocean was born, the western end of the Tethys was reduced to a Mediterranean Sea, Europe was still an archipelago and intercontinental seas covered large areas of the European platform and of western Asia. Between the stable Eurasian platform and the relics of the western Tethys, an elongate deep basin had formed and north of India a marine connection stretched to the west Pacific.

#### 5. PALEOENVIRONMENT

A study of abundant, well preserved Early Paleogene Southern Tethys benthic foraminiferal assemblage in Egypt and Pakistan represents the "Midway-type fauna (MF)" which named after Berggren & Aubert (1975), and indicates to the middle-outer shelf foraminiferal fauna (50-200 m water depth). Berggren (1974b) noted that the foraminiferal assemblage in Mali (S. Tethys) is dominated by shallow-water species (i.e. *Elphidiella*

*africana*), while the is developed in two lithotopes, one similar to that in Mali, and the other developed in a deeper-water basinal environment containing a MF of fauna, it is not difficult to see the close microfaunal relationship between the Paris Basin (N. Tethys) and the foraminiferal complex in Mali (S. Tethys), and the stratigraphic level through which *E. africana* is developed in Egypt corresponds with the upper part of the more complete stratigraphic range of this species in Mali. Keller (1988) noted that the benthic foraminiferal assemblages of E1 Kef, Tunisia provide insight into the paleoecology of an upper slope to middle shelf environment during the early Paleogene time. Meulenkamp & Sissingh (2003) considered the Arabian Platform still largely covered by sea in Paleocene-Middle Eocene was subjected to a major regression in the Middle-Late Eocene time. Bernaola et al. (2007) noted that the highly diverse and heterogeneous benthic foraminiferal assemblages from the Spain (N. Tethys) indicate well-oxygenated bottom water. Bejaoui et al. (2019) noted that the temporal variations of specialist and opportunist benthic foraminiferal assemblages occurring in reverse trends are interpreted to express fluctuating oligotrophic to mesotrophic conditions in Tunisia, and these conditions became temporarily disrupted by intermittent eutrophic trends related to the cooling event and associated changes in deep water masses (e.g., upwelling currents, regressive cycle).

## 6. CONCLUSIONS

A review of the paleontology and paleogeographic distribution of twenty one Southern Tethys is discussed and documented, for the first time. Twenty one Southern Tethyan benthic foraminiferal species (13 species of them are from Egypt and 8 species from Pakistan) are presented and recorded in some localities in the Northern Tethys of Europe (Spain, Gulf of Biscay, France, Italy, Hungary, Slovenia, North Atlantic). 15 species of this assemblage are recorded in France, 5 species in Spain, 3 species in Italy, 2 species in North Atlantic and other 2 species in Hungary, while one only species in Slovenia and other one species in Gulf of Biscay. The unclosed number of the recorded species in different localities of the Tethys may due to the lack of detailed studies, land barriers, different paleoenvironmental conditions (i.e. temperature, depth, dissolved oxygen, salinity, etc.) and / or not homogeneity of the generic and specific concepts according to different authors. Based on the faunal distribution of the recorded species, it emphasized that the Tethys extends from Atlantic Ocean in the west to Indo-Pacific Ocean in the east via Mediterranean in the Early Paleogene time.

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