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RESEARCH ARTICLE

PALEONTOLOGY, PALEOENVIRONMENT AND PALEOGEOGRAPHY OF THE EARLY PALEOGENE PAKISTANIAN BENTHIC FORAMINIFERAL SPECIES OF HAQUE - SUBORDER TEXTULARIINA (AGGLUTINATED FORAMINIFERA)

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ABSTRACT

The present study is a part of the comprehensive works concerned with the complete record of the Paleogene small benthic foraminiferal content in the Ranikot and Laki Formations of the Nammal Gorge, Salt and Sor Ranges of Pakistan. The first part was concerned with the Miliolina and Lagenina foraminiferal assemblage of Haque from Pakistan, and followed by the second part which concerned with the Rotaliid assemblage of the same author of Pakistan. The third part is concerned with the Textulariid part and presented in this study. Twenty one Early Paleogene Pakistanian smaller Textulariid (Agglutinated) benthic foraminiferal species and subspecies from the Ranikot and Laki Formations of the Nammal Gorge, Salt and Sor Ranges of Pakistan have been studied and are systematically listed. This systematic description provides a list of modern synonyms, short remarks about morphological features, and some annotations about taxa with problematic generic status. These species are: *Spiroplectinella ushbali*, *Gaudryina nitida*, *Siphogaudryina daviesi*, *S. elongata*, *S. nammalensis*, *Verneuilina laevigata*, *Tritaxia elongata*, *T. limbata*, *Dorothia nammalensis*, *Marssonella nammalensis*, *Bigenerina khirthari*, *B. metingensis*, *B. nodosa*, *Textularia crookshanki*, *T. haquei*, *T. punjabensis*, *Clavulinoides lakiensis*, *C. spatha*, *C. symmetrica*, *Valvulina n. nammalensis*, *V. nammalensis longa*. Most of the recorded species are an endemic to Pakistan, except five species *Siphogaudryina elongata*, *Tritaxia elongata*, *T. limbata*, *Textularia crookshanki* and *T. punjabensis* are recorded in some Northern Tethys (France, Hungary) and Southern Tethys (India, Iran, UAE, Egypt, Algeria). The paleoenvironmental interpretations of the identified species in the study area of Pakistan were deposited in somewhat deep water and open-marine environments. The abundance of pelagic Pakistanian benthic foraminiferal assemblages indicate an open connection to the Tethys, which represents middle-outer neritic environment (100-200 m depth) and shows an affinity with the Atlantic-Tethyan Regions: "Midway Type Fauna ".

KEYWORDS

Agglutinated foraminifera, Paleogene, Haque, Pakistan, Southern and Northern Tethys.

1. INTRODUCTION

The initial phase of this study was done in the assemblage of suborders Miliolina, Lagenina and Rotaliina by the present author (2021a, b). This paper is the third part of the same sequence of Early Paleogene benthic foraminiferal assemblages of the Ranikot and Laki Formations of the Nammal Gorge, Salt and Sor Ranges of Pakistan, which concerned with taxonomy, paleobathymetry, paleoecology, paleogeography and stratigraphic distribution on the suborder Textulariina assemblage (Figure 1). The twenty one smaller agglutinated benthic foraminiferal species and subspecies have been studied, which most of these Pakistanian species of Haque are, so far, an endemic to Pakistan. It is my intent in this study also to examine the stratigraphy, taxonomic consideration according to the modern taxonomy, interpreted the paleoenvironment, and also the paleogeographic distribution of this assemblage in the Southern and Northern Tethys. This study proved that five of this assemblage are recorded by some authors in many parts outside Pakistan in Northern and Southern Tethys, these are: *Siphogaudryina elongata*, *Tritaxia elongata*, *T. limbata*, *Textularia crookshanki* and *T. punjabensis*, which recorded in many localities in the Southern Tethyan: India, Iran, United Arab Emirates (UAE), Jordan, Egypt, Algeria, and also Northern Tethys: France and Hungary (Figure 2).

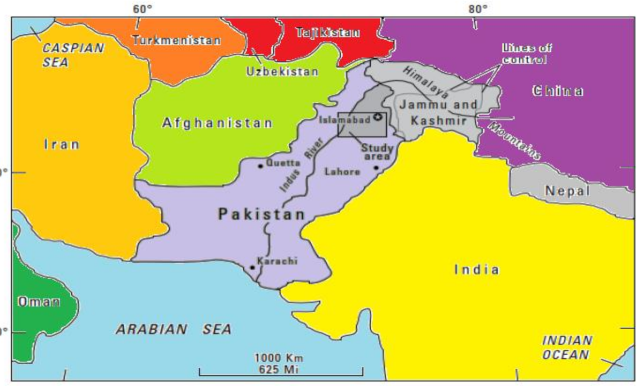

Figure 1: Location map of study area Salt Range, Northern Pakistan (after Gibson, 2007)

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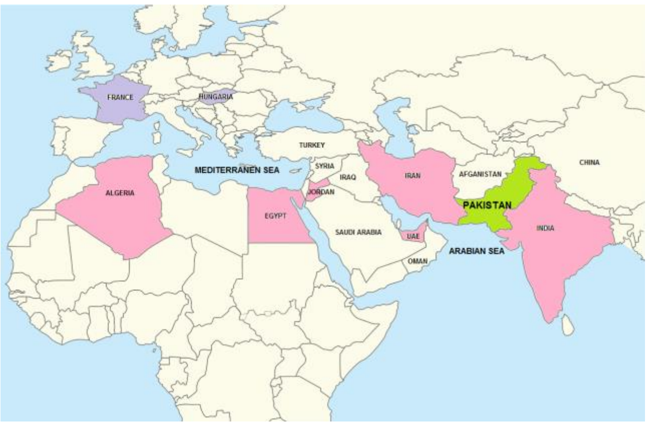

Figure 2: The geographic map showing the location of Pakistan and other Tethyan localities in Southern Tethys (India, Iran, UAE, Jordan, Egypt, Algeria) and Northern Tethys (France, Hungaria)

2. Stratigraphy

Based on the stratigraphic distribution of the planktonic, small benthic foraminifera, larger foraminifera and calcareous nannoplankton assemblages which recovered by many authors, i. e.: (Haque, 1956, 1960, 1962; Dorreen, 1974; Gibson, 1990, 2007; Afzal, 1996; Bybell and Self-Trail, 2007; Naz et al., 2011; Özcan et al., 2015; Ahmad et al., 2016; Khawaj et al., 2018; Anan, 2019; 2020a,b; 2021a,b,c). The Ranikot and Laki Formations of the Nammal Gorge, Salt and Sor Ranges of Pakistan indicate that these strata are in the Late Paleocene-Early Eocene age. The Patala Formation is very late Paleocene and the Nammal Formation (overlies the Patala Fm.) is early Eocene in age, and the earliest Eocene strata are missing due the disconformity at the Paleocene-Eocene boundary. On the other hand, a researcher noted that the Ranikot beds of Pakistan may be correlated to the Esna Shale (Paleocene-Early Eocene) of Egypt (Haque, 1956). He also noted that many foraminiferal forms which were recorded from Europe, America and Egypt are also recorded in the Laki Formation of Pakistan.

3. Taxonomy

Some modern references have been added to complete description, and taxonomic considerations. The generic concept of the twenty two identified agglutinated species in this study are adapted according to the taxonomic classification of a previous researcher and presented in Plate 1 (Loeblich and Tappan 1988).

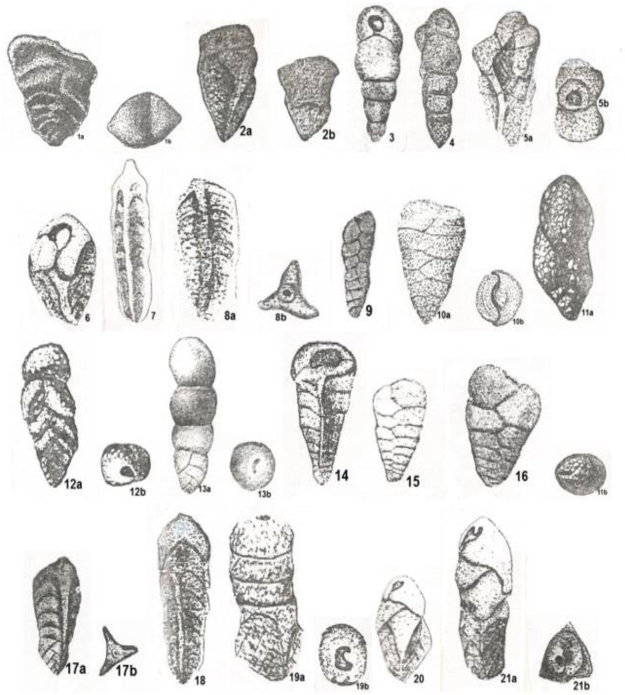

Plate 1: (all figures: a: side view, b: apertural view): **1a, b.** *Spiroplectinella ushbali* (Haque, 1960) x 40; **2a, b.** *Gaudryina nitida* Haque, 1960 x 40; **3.** *Siphogaudryina daviesi* (Haque, 1956) x 45; **4.** *Siphogaudryina elongata* (Haque, 1956) x 35; **5a, b.** *Siphogaudryina nammalensis* (Haque, 1956) x 30; **6**. *Verneuilina laevigata* Haque, 1956 x 40; **7**. *Tritaxia elongata* (Haque, 1956) x 25; **8a, b.** *Tritaxia limbata* (Haque, 1956) x 45; **9.** *Dorothia nammalensis* Haque, 1956 x 35; **10a, b.** *Marssonella nammalensis* Haque, 1956 x 50; **11a, b**. *Bigenerina khirthari* Haque, 1960 x 50; **12a, b.** *Bigenerina metingensis* Haque, 1962 x 50; **13a, b.** *Bigenerina nodosa* Haque, 1956 x 45; **14.** *Textularia crookshanki* Haque, 1956 x 45; **15.** *Textularia haquei* Anan, 2020 x 45; **16.** *Textularia punjabensis* Haque, 1956 x 40; **17a, b.** *Clavulinoides lakiensis* Haque, 1956 x 35; **18.** *Clavulinoides spatha* Haque, 1956 x 40; **19a, b.** *Clavulina symmetrica* Haque, 1956 x 45; **20.** *Valvulina nammalensis* Haque, 1956 x 35; **21a, b.** *Valvulina nammalensis longa* Haque, 1956 x 35.

Order Foraminiferida Eichwald, 1830
Suborder Textulariina Delage & Hérouard, 1896
Superfamily Spiroplectamminacea Cushman, 1927
Family Spiroplectamminidae Cushman, 1927
Subfamily Spiroplectammininae Cushman, 1927
Genus *Spiroplectinella* Kisel'man, 1972
Type species *Spiroplecta wrightii* Silvestri, 1903

Spiroplectinella ushbali (Haque 1960) - (Pl. 1, figure 1a, b)

1960 *Textularia ushbali* Haque, p. 18, pl. 3, figure 7.

Remarks: This Early Eocene species belongs to the genus *Spiroplectinella* Kisel'man due to its early planispiral coil stage, followed by biserial chambers in the later stage. The Textulariid genus *Spiroplectinella* Kisel'man (1972) has early planispiral coil and lozenge biserial shaped in section, than large early planispiral coil and broadly rounded margins in the genus *Spiroplectammina* Cushman (1927), or large planispiral coil in early stage and later long and narrow biserial stage in the genus *Bolivinopsis* Yakovlev (1891).

Superfamily Verneuilinacea Cushman, 1911
Family Verneuilinidae Cushman, 1911
Subfamily Verneuilininae Cushman, 1911
Genus *Gaudryina* d'Orbigny, 1839
Type species *Gaudryina rugosa* d'Orbigny, 1840

Gaudryina nitida Haque, 1956 - (Pl. 1, figure 2a, b)

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

2021c *Gaudryina nitida*; Anan, p. 271, pl. 1, figure 4.

Remarks: This Late Paleocene 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.

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

Siphogaudryina daviesi (Haque, 1956) - (Pl. 1, figure 3)

1956 *Gaudryina daviesi*, Haque, p. 37, pl. 31, figure 14.
2019 *Siphogaudryina daviesi*; Anan, p. 31, pl. 1, figure 3.
2021c *Siphogaudryina daviesi*; Anan, p. 272, pl. 1, figure 8.

Remarks: This Late Paleocene-Early Eocene 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 Pakistanian Early Eocene form *daviesi* is more resemble the Egyptian Paleocene form *elegantissima* Said & Kenawy (1956). This species was recorded from Pakistan and Egypt.

Siphogaudryina elongata (Haque, 1956) - (Pl. 1, figure 4)

1956 *Gaudryina laevigata* Franke var. *elongata* Haque, p. 35, pl. 9, figure 5.
2021c *Gaudryina elongata*; Anan, p. 272, pl. 1, figure 9.

Remarks: This Late Paleocene-Early Eocene species belongs here to the genus *Siphogaudryina*. It seems that the Jordanian *tellburmaensis* Futyan (1976) is most related to Haque's *elongata* (Pakistan), but differs in its acute curved test, and more added triserial portion. This species was recorded, so far, from Pakistan.

Siphogaudryina nammalensis (Haque, 1956) - (Pl. 1, figure 5a, b)

1956 *Gaudryina (Siphogaudryina) carinata* Franke *nammalensis* Haque, p.

40, pl. 3, figure 2.
2021c *Siphogaudryina nammalensis*; Anan, p. 273, pl. 1, figure 11.

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.

Genus *Verneuilina* d'Orbigny, 1839
Type species *Verneuilina tricarinata* d'Orbigny, 1839
Verneuilina laevigata Haque, 1956 - (Pl. 1, figure 6)
1956 *Verneuilina laevigata* Haque, p. 34, pl. 21, figure 9, 12.
2021c *Verneuilina laevigata*; Anan, p. 275, pl. 1, figure 17.

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.

Family Tritaxiidae Plotnikova, 1979
Genus *Tritaxia* Reuss, 1860
Type species *Rhabdogonium* Berthelin, 1879

Tritaxia elongata (Haque, 1956) - (Pl. 1, figure 7)

1956 *Clavulinoides lakiensis elongata* Haque, p. 45, pl. 21, figure 13.
1996 *Tritaxia lakiensis elongata*; Anan, p. 150, figure 3.5
2019 *Tritaxia elongata*; Anan, p. 31, pl. 1, figure 1.

Remarks: This Early Eocene species belongs here to the genus *Tritaxia* due to its triangular cross section along the elongate test. This species was recorded from Jabal Hafit, UAE and Pakistan (Anan 1996, 2019).

Tritaxia limbata (Haque, 1956) - (Pl. 1, figure 8a-c)
1956 *Clavulinoides lakiensis limbata* Haque, p. 45, pl. 21, figure 8.
1996 *Tritaxia lakiensis limbata*; Anan, p. 150, figure 3.6.
2019 *Tritaxia limbata*; Anan, p. 31, pl. 1, figure 2.

Remarks: This Early Eocene species has triangular cross-section. It differs from *Tritaxia elongata* by its wider and less elongated test. It was recorded from Pakistan and UAE (Anan 20, 21).

Superfamily Textulariacea Ehrenberg, 1838
Family Eggerellidae Cushman, 1937
Subfamily Dorothiinae Balakhmatova, 1972
Genus *Dorothia* Plummer, 1931
Type species *Dorothia bulletta* Carsey, 1926
Dorothia nammalensis Haque, 1956 - (Pl. 1, figure 9)
1956 *Dorothia pupoides* (d'Orbigny) *nammalensis* Haque, p. 53, pl. 32, figure 4.

Remarks: This Late Paleocene species has elongate tapering initial end test with nearly parallel sides, early stage has many chambers per whorl, then reduced to biserial. It closely resembles the Eocene *D. sinaensis* Said & Kenawy (1956), but differs in its lesser width and older stratigraphic horizon. It is, so far, an endemic to Pakistan.

Genus *Marssonella* Cushman, 1933
Type species *Gaudryina oxycona* Reuss, 1860

Marssonella nammalensis Haque, 1956 - (Pl. 1, figure 10a, b)

1956 *Marssonella oxycona* (Reuss) *nammalensis* Haque, p. 50, pl. 3, figure 4.

Remarks: This Late Paleocene Pakistanian variety is characterized by its conical test, circular equatorial cross-section and flattened apertural face. It differs from *M. oxycona* by its less number of chambers and less tapering initial end. It is, so far, an endemic to Pakistan.

Family Textulariidae Ehrenberg, 1838
Subfamily Textulariinae Ehrenberg, 1838
Genus *Bigenerina* d'Orbigny, 1826

Type species *Bigenerina nodosaria* d'Orbigny, 1826

Bigenerina khirthari Haque, 1960 - (Pl. 1, figure 11a, b)

1960 *Bigenerina khirthari* Haque, p. 18, pl. 3, figure 4.

Remarks: This Early Eocene species has coarsely agglutinated wall test, with a large proportion of light-grey cement with coarse angular mineral fragments, tapering early biserial part, later alternating uniserial ending by elliptical terminal aperture. It is, so far, an endemic to Pakistan.

Bigenerina metingensis Haque, 1962 - (Pl. 1, figure 12a, b)

1962 *Bigenerina khirthari* Haque, p. 18, pl. 3, figure 4.

Remarks: This Early Eocene species has mainly elongated test, the biserial initial portion consists the most test, while the uniserial portion ended the test with perform-shape aperture near the edge. It is, so far, an endemic to Pakistan.

Bigenerina nodosa Haque, 1956 - (Pl. 1, figure 13a, b)

1956 *Bigenerina nodosa* Haque, p. 33, pl. 3, figure 7, 8.

Remarks: This Late Paleocene species is characterized by its elongate test, one-third biserial initial chambers followed by three semi-globular uniserial chambers, sutures distinct and depressed, wall arenaceous but smoothly finished, aperture crescent terminal. It is, so far, an endemic to Pakistan. Genus *Textularia* Defrance, 1824

Type species *Textularia sagittula* Defrance, 1824

Textularia crookshanki Haque, 1956 - (Pl. 1, figure 14)

1956 *Textularia crookshanki* Haque, p. 32, pl. 9, figure 9.
2000 *Textularia crookshanki*; Sztrákos, p. 157.
2005 *Textularia crookshanki*; Sztrákos, p. 184.
2007 *Textularia crookshanki*; Ozsvárt, p. 35, pl. 1, figure 20.
2020b *Textularia crookshanki*; Anan, p. 72, pl. 1, figure 6.

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 (Southern Tethys), and later from Northern Tethys: France (Sztrákos 2000, 2005) and Hungary (Ozsvárt, 2007).

Textularia haquei Anan, 2020 - (Pl. 1, figure 15)

1956 *Textularia* sp. Haque, p. 32, pl. 9, figure 10, 11.
2020a *Textularia haquei;* Anan, p. 3, pl. 1, figure 6.

Remarks: This Late Paleocene Pakistanian species is closely related to the Early Eocene Egyptian species *T. farafraensis* LeRoy (1953), but differs by its smaller test, moderate coarse wall, and recorded in an older stratigraphic level. This species was recorded, so far, from Pakistan.

***Textularia punjabensis* Haque, 1956 - (Pl. 1, figure 16)**

1956 *Textularia punjabensis* Haque, p. 31, pl. 9, figure 12
1990 *Textularia punjabensis*; Habibnia & Mannikeri, p. 4, pl. 1, figure 5,6
2005 *Gaudryina* sp. Sztrákos, p. 218, pl. 11, figure 29
2016 *Textularia punjabensis*; Orabi & Zaky, p. 187, pl. 2, figure 18
2016 *Textularia* sp. VahdatiRad, p. 6, pl. 2, figure 22
2019 *Textularia punjabensis* Haque; Anan, p. 31, pl. 1, figure 6.

Remarks: This Late Paleocene-Early Eocene species is characterized by its biserial test with coarsely agglutinated sand grains. It seems that the figured French specimen *Gaudryina* sp. Sztrákos (2005), and the Iranian *Textularia* sp. of VahdatiRad (2016) are closely related to the Pakistanian *T. punjabensis* Haque. Generally, it was recorded from Northern Tethys: France (Sztrákos (2005), and Southern Tethys: Iran (VahdatiRad (2016), India (Habibnia & Mannikeri (1990), Egypt (Orabi & Zaky, 2016).

Family Pseudogaudryinidae Loeblich &Tappan, 1985
Subfamily Pseudogaudryininae Loeblich &Tappan, 1985
Genus *Clavulinoides* Cushman, 1936
Type species *Clavulina trilatera* Cushman, 1926

Clavulinoides lakiensis Haque, 1956 - (Pl. 1, figure 17a, b)

1956 *Clavulinoides lakiensis* Haque, p. 43, pl. 21, figure 7; p. 54, pl. 32, figure 1.

Remarks: This Late Paleocene species has elongate test, triangular throughout, early chambers triserial, later abruptly becoming uniserial with terminal rounded aperture. This species was recorded, so far, from Pakistan.

Clavulinoides spatha Haque, 1956 - (Pl. 1, figure 18)

1956 *Clavulinoides lakiensis spatha* Haque, p. 44, pl. 21, figure 6.

Remarks: This Late Paleocene species differs from *C. lakiensis* in its more elongated test. This species was recorded, so far, from Pakistan.

Genus *Pseudoclavulina* Cushman, 1936

Type species *Clavulina clavata* Cushman, 1926

The Paleocene *Pseudoclavulina pseudohumilis* Haque (1956, pl. 9, figure 1) and *P. paxilliformis* Haque (1956, pl. 12, figure 6, 8) are treated in this study as a junior synonym of *P. farafraensis* LeRoy (1953, pl. 2, figure 9) and *P. globulifera* ten Dam & Sigal (1950, pl. 2, figure 5-7), respectively.

Family Valvulinidae Berthelin, 1880
Subfamily Valvulininae Berthelin, 1880
Genus *Clavulina* d'Orbigny, 1826
Type species *Clavulina parisiensis* d'Orbigny, 1826

Clavulina symmetrica Haque, 1956 - (Pl. 1, figure 19a, b)

1956 *Clavulina paxilliformis symmetrica* Haque, p. 50, pl. 24, figure 6.

Remarks: This Late Paleocene species has elongate test, triserial and triangular early stage, later uniserial discoidal chambers, aperture terminal with semilunate form. This species was recorded, so far, from Pakistan.

Genus *Valvulina* d'Orbigny, 1826
Type species *Valvulina triangularis* d'Orbigny, 1826

Valvulina n. nammalensis Haque, 1956 - (Pl. 1, figure 20)

1956 *Valvulina nammalensis* Haque, p. 47, pl. 21, figure 10 (*non* figure 11).

Remarks: This Late Paleocene subspecies has short triserial triangular in transverse section with angular angles, the last chambers in the final whorl abruptly larger than preceding chambers, aperture a narrow semicircular opening at the base of the last-formed chambers. The Maastrichtian-Paleocene Egyptian species *V. aegyptiaca* Said & Kenawy differs from the *V. nammalensis* Haque by its rounded periphery than angular in the latter. It was recorded, so far, from Pakistan.

Valvulina nammalensis longa Haque, 1956 - (Pl. 1, figure 21a, b)

1956 *Valvulina nammalensis* Haque, p. 47, pl. 21, figure11 (*non* figure 10).

Remarks: This Late Paleocene subspecies is closely related to *Valvulina n. nammalensis*, but differs in having a longer test in relation to its normal long size, and may have given rise to it, as the typical form occurs in the same area. It was recorded, so far, from Pakistan.

4. Paleogeography

The paleogeographic maps (partly or regionally) of Berggren (1971), Mintz (1981), Rosenbaum et al. (2002) showing 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 Paleogene time (Figure 3). Seventeen of the Pakistanian agglutinated foraminifera are, so far, endemic to Pakistan, while another four species from the faunal assemblage are recorded in some localities in the Southern Tethys: India, Iran, Egypt (*Textularia punjabensis*), UAE (*Tritaxia elongata*, *Tritaxia limbata*), and also some Northern Tethys localities: France and Hungary (*Textularia crookshanki*). The number differences of the recorded species between the different localities in the Tethys may be due to one or more parameters: the deficiency of available literatures, differences in ecological or environmental conditions (depth, salinity, water temperature, dissolved oxygen, nutrient, land barrier) and not homogeneity in the generic or species concept according to different authors.

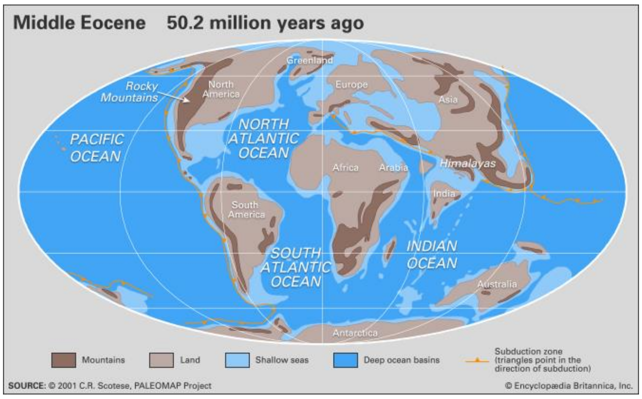

Figure 3: The Paleogene paleogeographic map showing the connected ancestral Atlantic, Indian and Pacific Oceans

5. Paleoecology and Paleoenvironment

The foraminiferal contents of the Paleocene-Early Eocene succession at the Ranikot and Laki Formations of the Nammal Gorge, Salt and Sor Ranges of Pakistan have been investigated to assess the paleoenvironmental conditions prevailing during the deposition of these strata, and Gibson (2007) noted that the Patala Formation in the western Salt Range, Nammal Gorge area were deposited in somewhat deeper water, open-marine environments. 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, and the "Flysch-type Assemblage, FTA" result from the exclusion of calcareous benthic foraminifera below a local CCD (Calcareous Compensation Depth). The local tectonic and sedimentological vents may have been important in the replacement of agglutinated assemblages. Van der Zwaan (1982) indicates that *Spiroplectinella* has no tolerance for variations in oxygen content and salinity, and it is present in outer shelf (70-100) meter sediments and prefers muddy substrate. Corliss (1982) postulated that the mode of life of a taxon can be deduced from the morphology of its test and the endobenthic species (e.g. *Spiroplectammina, Spiroplectinella*) live under the water/sediment interface and they burrow through the sediments, where they can tolerate less oxygenated conditions, and Hewaidy et al. (2014) noted that the calcareous agglutinated foraminiferal genus *Spiroplectinella* is interpreted as of shelf environment. Bejaoui et al. (2019) considered some agglutinated genera (e.g. *Spiroplectinella*) belongs to characteristics bathyal to abyssal environment with high terrigenous sedimentation rate and associated moderate organic flux. 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. Anan (2021c) concluded that some genera of the Suborder Verneuilinidae (e. g. *Gaudryina, Siphogaudryina, Verneuilina*) are restricted to deep marine environments.

6. Summery and Conclusions

The rich and well preserved Paleocene-Eocene agglutinated benthic foraminifera of the study area in Pakistan it possible to clarify some aspects of modern taxonomic consideration, stratigraphy, paleoecology and paleoenvironments. The Paleocene Patala Formation in the western Salt Range, Nammal Gorge area were deposited in somewhat deep water, open-marine environments. The Nammal Formation, which overlies the Patala, is early Eocene in age, and the earliest Eocene strata are missing due the disconformity at the Paleocene-Eocene boundary. The twenty one agglutinated foraminiferal species and subspecies were firstly recorded from Pakistan by Haque (1956, 1960, 1962). Most of the recorded species are, so far, an endemic to Pakistan. This study proved that except five species (19 %) of them (*Siphogaudryina elongata*, *Tritaxia elongata*, *T. limbata*, *Textularia crookshanki* and *T. punjabensis*) were recorded in many other Tethyan localities in the Southern Tethys (India, Iran, UAE, Jordan, Egypt, Algeria) and also in the Northern Tethys (France, Hungary). The probable paleoenvironment of the recorded fauna of the studied area in Pakistan are deposited in somewhat deep water, open-marine middle-upper bathyal environment, and also indicate an open connection to the Tethys, which represents middle-outer neritic environment (100-200 m depth) and shows an affinity with the Atlantic-Tethyan Regions: "Midway Type Fauna ".

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REFERENCES

Afzal, J. 1996. Late Cretaceous to Early Eocene foraminiferal biostratigraphy of the Rakhi Nala area, Sulaiman Range, Pakistan. Pakistan Journal of Hydrocarbon Research, 8(1), Pp. 1-24.

Ahmad, S., Kroon, D., Rigby, S., Hanif, M., Khan, S., Ali, F., Irfan, U. Jan, Ali, F., Hafiz, S.H. 2016. Endemic vs cosmopolitan Tethyan benthic foraminifera from the lower Eocene Panoba Formation, Kohat subbasin, Pakistan: implications for Early Eocene warming. Journal of Himalayan Earth Sciences 49(1), Pp.131-143.

Anan, H.S. 1996. Early Eocene foraminifera of Jabal Hafit, United Arab Emirates. Middle East Research Center, Ain Shams University, Earth Science Series, Cairo, 10, Pp.147-162.

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

Anan, H.S. 2020a. Taxonomic consideration and stratigraphic implication of the accelerated evolution of the Maastrichtian-Eocene transition of twenty benthic foraminiferal species in the Tethys. Earth Science Pakistan (ESP), 4(1), Pp. 1-6.

Anan, H.S. 2020b. Southern Tethys benthic foraminifera in Northern Tethys. Earth Science Pakistan, 4(2), Pp.70-75.

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

Anan, H.S. 2021b. Paleontology, paleoenvironment and paleogeography of the Early Paleogene Pakistanian benthic foraminiferal species of Haque-Suborders Rotaliina. Earth Science Pakistan (ESP), 5(2), Pp.56-67.

Anan, H.S. 2021c. Representatives of some diagnostic agglutinated foraminiferal genera of the Suborder Verneuilinina (*Plectina, Gaudryina, Siphogaudryina, Verneuilina*) in the Southern Tethys. International Journal of Innovative Science, Engineering and Technology (IJISET), 8(6), Pp.269-281.

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, Pp.500-530.

Berggren, WA. 1971. Micropaleontology and Cenozoic paleoclimatology, part II: 277-299 (in Berggren and Phillips: Influence of the Continental drift on the distribution of the Tertiary benthic foraminifera in the Caribbean and Mediterranean regions), In: Gray C. (Ed.): Symposium on the geology of Libya. Faculty of Science, University of Libya: Tripoli, Pp. 263–299.

Bybell, L.M., Self-Trail, J.M. 2007. Calcareous Nannofossils from Paleogene Deposits in the Salt Range, Punjab, Northern Pakistan. USGS Bulletin 2078-B (Regional Studies of the Potwar Plateau Area, Northern Pakistan), 15.

Corliss, B.H. 1985. Microhabitats of benthic foraminifera within deep-sea sediments. Nature, 314, Pp. 435-438.

Cushman, J.A. 1927, An outline of the re-classification of the Foraminifera. Contributions from the Cushman Laboratory for foraminiferal Research, 3, Pp.1-105.

Dam, A., Sigal, J. 1950. Some new species of foraminifera from the Dano-Montian of Algeria. Cushman Foundation for Foraminiferal Research, 1, Pp. 31-37.

Dorreen, J.M. 1974, The western Gaj River section, Pakistan, and the Cretaceous-Tertiary boundary. Micropaleontology, 20(2), Pp.178-193.

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

Gibson, Th. G. 1990. Upper Paleocene foraminiferal biostratigraphy and paleoenvironments of the Salt Range, Punjab, Pakistan. U.S. Department of the Interior U.S. Geological Survey, Open-File Report, 91-112, Pp. 1-55.

Gibson, Th. G. 2007. Upper Paleocene foraminiferal biostratigraphy and paleoenvironments of the Salt Range, Punjab, Northern Pakistan. USGS Bulletin 2078-E (Regional Studies of the Potwar Plateau Area Northern Pakistan), 14p.

Habibnia, B.A., Mannikeri, M.S. 1990. Smaller foraminifera from Eocene beds of Jaisalmer District, Western Rajasthan. Journal of the Palaeontological Society of India, 35, Pp. 1-15.

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.1-79.

Haque, A.F.M.M. 1962. The smaller foraminifera of the Meting Limestone (Lower Eocene) Meting, Hyderabad Division, West Pakistan. Pakistan Geological Survey Memoir, Palaeontologica Pakistanica, 2(1), Pp.1-43.

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, Pp. 1-38.

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

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.

Kisel'man, E.N. 1972. Upper Cretaceous and Paleocene new foraminiferal genus *Spiroplectinella*. Trudy Sibirskogo Nauchno-Issledovatel'skogo Instituta Geologii Geojiziki i Mineral'nogo Syr'ya (SNIIG- GIMS) Ministerstva Geologii i Okhrany Nedr SSSR, Novosibirsk, 146, Pp. 134–140.

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, 970 p., part 2, 847.

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), Pp. 1-30.

Mintz, LW. 1981. Historical Geology, the Science of a Dynamic Earth. In: The fountainhead of Stratigraphy: The Mesozoic Erathem. 3rd Ed. Merrill Publication Company: USA, Pp. 434–502.

Naz, H., Usmani, P.A., Lashari, R.A. 2011. Planktonic zonation from the contact of Laki Formation (Early Eocene) and Tiyon Formation (Middle Eocene) Thana Bula Khan, Lower Indus Basin, Sindh, Pakistan. Journal of Himalayan Earth Sciences, 44(2), Pp.17-23.

Orabi H.O., Zaky, A.S. 2016. Differential dissolution susceptibility of Paleocene foraminiferal assemblage from Farafra Oasis, Egypt. Journal of African Earth Sciences, 113, Pp. 181-193.

Özcan, E., Hanif, M., Ali, N., Yücel, A.O. 2015. Early Eocene Orthophragminids (Foraminifera) from the type-locality of Discocyclina ranikotensis Davies, 1927, Thal, NW Himalayas, Pakistan: insights into the Orthophragminid palaeobiogeography. Geodinamica Acta, 27(4), Pp. 267-299.

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

Rosenbaum, G., Lister G.S., Duboz, C. 2002. Relative motions of Africa, Iberia and Europe during Alpine orogeny. Tectonophysics, 359(1-2): Pp. 117–129.

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

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

Sztrákos, K. 2005. Paleocene and lowest Eocene foraminifera from the north Pyrenean trouph (Aquitaine, France). Revue de Micropaléontologie, 48, Pp. 175-236.

Ten Dam, A., Sigal, J. 1950. Some new species of Foraminifera from the Dano-Montian of Algeria. Contributions from the Cushman Laboratory for Foraminiferal Research, 1 (1, 2), Pp. 130-131.

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

Yacovlev, V. 1891. Opisanieneskol'kikh vidov Melovykh foraminifer [Description of some species of Cretaceous foraminifera], Trudy Khar'kovskogo Obshchestva Ispytateley Prirody, 24, Pp. 341-364.

Zwaan, van der G.J. 1982. Palaeoecology of Late Miocene Mediterranean foraminifera. Utrecht Micropal. Bulletin, 25, 202.