

REVIEW ARTICLE

PALEONTOLOGY AND PALEO GEOGRAPHY OF THE TETHYAN EARLY PALEOGENE ROTALIID BENTHIC FORAMINIFERAL PAKISTANIAN GENUS *ORNATANOMALINA* AND OTHER RELATED GENERA

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ABSTRACT

Six Early Paleogene small Rotaliid benthic foraminiferal species of the genus *Ornatanolina* Haque are common in Pakistan and some of them are recorded from some localities in the Southern Tethys (Iraq, Qatar, United Arab Emirates, Nigeria), as well as Northern Tethys (Italy, France): *O. acuta*, *O. crookshanki*, *O. elegantula*, *O. geei*, *O. glaessneri*, *O. hafeezi*. Another one of the illustrated species of Pakistan is believed to be new: *O. pakistanica* Anan, n. sp. Moreover, another one species of the genus was recorded earlier from the Early Eocene rocks of the United Arab Emirates (UAE): *O. ennakhali*. The taxonomic status of the genus *Ornatanolina* Haque with the other related genera, as *Thalmanita* (Bermúdez) and *Saudella* Hasson are also discussed.

KEYWORDS

Paleontology, stratigraphy, paleogeography, foraminifera, Paleogene, Tethys.

1. INTRODUCTION

The paleontological occurrence the genus *Ornatanolina* and its eight species has been recorded originally from Pakistan and later from some other Southern and Northern Tethyan localities (Haque, 1956; 1960). The present study aims at throwing light on: 1) to present together many data scattered in the literature for this genus under a unifying theme, 2) to detect its paleontology, stratigraphy and paleogeographic distribution of the different species of that genus, 3) to present a new species *Ornatanolina pakistanica*, 4) to discuss the taxonomic status of the genus with the other related genera, as *Thalmanita* and *Saudella* (Bermúdez, 1952; Hasson, 1985).

2. TAXONOMY

Eight Early Paleogene Rotaliid benthic foraminiferal species of the genus *Ornatanolina* and its species are identified and illustrated in Plate 1. The classification is followed in this study (Loeblich and Tappan, 1988). According to these authors the two genera: *Ornatanolina* and *Saudella* appear to be both congeneric, which doesn't accepted here (Haque, 1956; Hasson, 1985). *Ornatanolina* Haque is characterized in having ornamented surface with spiraling ribs that sharply angled and interrupted at the radial median ridges across the chamber surface, and has interiomarginal and equatorial aperture, while *Saudella* Hasson has different ornamentation which differing on the two sides, ventral area with coarse porous infilling may overlies extinctions of the chambers and supplementary apertures, and the primary aperture has a slit or rounded opening with smooth apertural face. One the other hand, a researcher noted that the aperture in the genus *Saudella* has a slit or rounded opening with smooth apertural face, which differs from the other two genera *Ornatanolina* Haque and *Thalmanita* that this ornamentation

continues across the apertural face, and no limbate border is present (Figure 1) (Hasson, 1985; Bermudez, 1952).



Figure 1: The geographic distribution of the genus *Ornatanolina* Haque in the different countries in Asia (Pakistan, UAE, Qatar, Iraq), Africa (Nigeria) and Europe (Italy, France).

Order Foraminiferida Eichwald, 1830
Suborder Rotaliina Delage & Hérouard, 1896
Superfamily Rotaliacea Ehrenberg, 1839
Family Rotaliidae Ehrenberg, 1839
Subfamily Cuvillierininae Loeblich & Tappan, 1964
Genus *Ornatanolina* Haque, 1956
Type species *Ornatanolina geei* Haque, 1956

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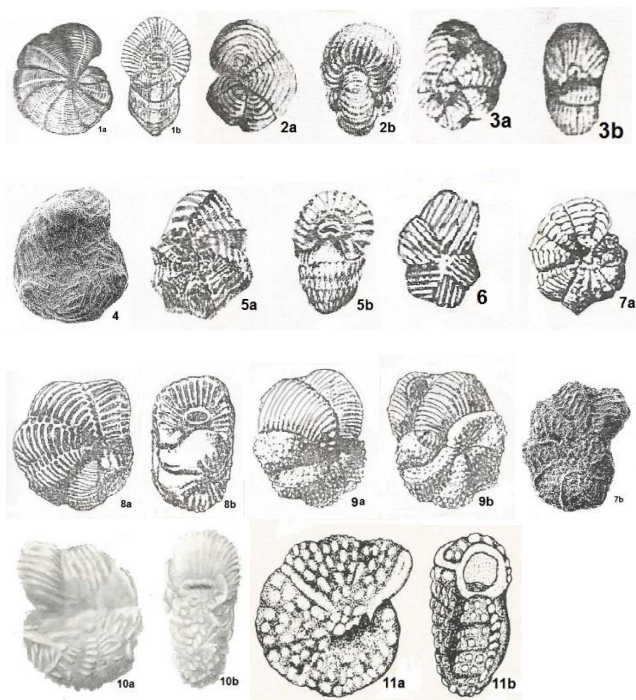


Plate 1: 1. *Ornatanolina acuta* Haque, 1956 x 70; 2. *O. crookshanki* Haque, 1956 x 40; 3. *O. elegantula* Haque, 1956 x 45; 4. *O. ennakhali* x 60; 5. *O. geei* x 50; 6. *O. glaessneri* x 70; 7. *O. hafeezi* Haque, 1956 x 40; 8. *O. pakistanica* Anan, n. sp. x 60; 9. *O. ? pustulosa* x 70; 10. *T. madrugensis* x 50; 11. *Saudella ornata* Hasson, 1985 x 60 (Anan, 2011; Haque, 1956; Haque, 1960; Cushman and Bermúdez, 1947).

Ornatanolina acuta Haque, 1956 - (Pl. 1, figure 1a, b)

1956 *Ornatanolina acuta* Haque, Pp. 201, pl. 22, figure 2.
Remarks: This Late Paleocene species has discoidal test, 9 chambers in the semicircular last whorl, surface ornamented by a spiraling ribs flush with the surface and interrupted at the radial median ridge, with median equatorial slit aperture. It is, so far, an endemic to Pakistan.

Ornatanolina crookshanki Haque, 1956 - (Pl. 1, figure 2a, b)

1956 *Ornatanolina crookshanki* Haque, Pp. 197, pl. 18, figure 10.
Remarks: This Late Paleocene species has only five chambers in the last whorl, spiraling ribs flush with the surface without interruption across the chamber surface, with an interiomarginal equatorial slit aperture. It is, so far, an endemic to Pakistan.

Ornatanolina elegantula Haque, 1956 - (Pl. 1, figure 3a, b)

1956 *Ornatanolina elegantula* Haque, p. 202, pl. 18, figure 3.
Remarks: This Late Paleocene species has compressed test, 6 chambers in the last whorl, surface ornamented by a spiraling ribs flush with and interrupted at the radial median ridge, with an elongate slit aperture perpendicular on the apertural face. It is, so far, an endemic to Pakistan.

Ornatanolina ennakhali Anan, 2011 - (Pl. 1, figure 4)

1996 *Ornatanolina* sp. Anan, p. 154, figure 4. 10.
2011 *Ornatanolina ennakhali* Anan, p. 63, pl. 3, figure 34.
2013 *Ornatanolina ennakhali* Anan - Anan, p. 115, pl. 3, figure 5.

Remarks: This late Early Eocene species differs from the type species *O. geei* Haque and its subspecies *O. geei compressa* and other Haque's species and subspecies from Pakistan by its discontinuous ribs, and lacking the radial median ridges across the chamber surface (Haque, 1956; 1960). *O. ennakhali* Anan was recorded in the Ypresian of the Rus Formation, J. Hafit in UAE. This contribution expands the paleogeographic distribution of the genus abroad Pakistan to another locality in the Southern Tethys: UAE (Anan, 1996; 2011). The illustrated specimens *O. hafeezi* of Haynes & Nwabufo-Ene (1988, pl. 2, figs. 1-3) from the Late Paleocene phosphatic bed, Kalambaina Formation, Sokoto Basin of Nigeria are more related to *O. ennakhali* in its discontinuous distribution of the surface ribs, but more elongated test than the semi-circular outline of the Early Eocene *O. ennakhali* test. The illustrated Middle Eocene paratype specimen *Thalmanita aquitanica* most probably belongs to *O. ennakhali*, due to its discontinuous distribution of the surface ribs, and lack several large

papillae in the early chambers of the final whorl and in the umbilical area as a distinct character of the genus *Thalmanita* (Sztrákos, 2000).

Ornatanolina geei (Haque, 1956) - (Pl. 1, figure 5a, b)

1956 *Ornatanolina geei* Haque, p. 196, pl. 18, figure 8.
1988 *Ornatanolina geei* Haque - Loeblich & Tappan, p. 657, pl. 753, figures. 6-8.

2007 *Ornatanolina geei* Haque - Gibson, E12.

Remarks: This Late Paleocene species was recorded originally from Pakistan, and represents the type species of the genus *Ornatanolina* (Haque, 1956). It is characterized by its discoidal test, 7-11 chambers weakly trochospiral in the early stage and later planispiral, rounded periphery, surface with spiraling ribs that sharply angled and interrupted at the radial median ridges across the chamber surface, aperture interiomarginal and equatorial. It is, so far, an endemic to Pakistan.

Ornatanolina glaessneri Haque, 1956 - (Pl. 1, figure 6)

1956 *Ornatanolina glaessneri* Haque, p. 199, pl. 18, figures. 4, 11.
Remarks: This Late Paleocene species has only five chambers in the last whorl, with characteristic ornamentation of oblique, interfingering proximal and distal ribs on each chambers. It is, so far, an endemic to Pakistan.

Ornatanolina hafeezi Haque, 1956 - (Pl. 1, figure 7a, b)

1956 *Ornatanolina hafeezi* Haque, p. 201, pl. 18, fig. 6.
1994 *Ornatanolina hafeezi* Haque - Hewaidy, p. 158.
1998 *Ornatanolina hafeezi* Haque - (Haynes and Nwabufo-Ene, p. 68, pl. 7, figures. 4-8 (non figs. 1-3) 2019 *Ornatanolina hafeezi* Haque - Anan, p. 33, pl. 2, fig. 17.

Remarks: The Pakistanian genus *Ornatanolina* Haque was considered as a senior synonym of *Saudella* from Saudi Arabia (SA), which not accepted here (Loeblich and Tappan, 1988; Hasson, 1985). These authors also considered *O. hafeezi* as a junior synonym of *O. geei*. Hewaidy (1994) considered the *O. hafeezi* Haque is synonymous to *S. rugosa* Hasson. The species *O. hafeezi* was recorded in some other localities in the Tethys, so far, Qatar and Nigeria (Figure 2) (Haynes and Nwabufo-Ene, 1998; Hewaidy, 1994).

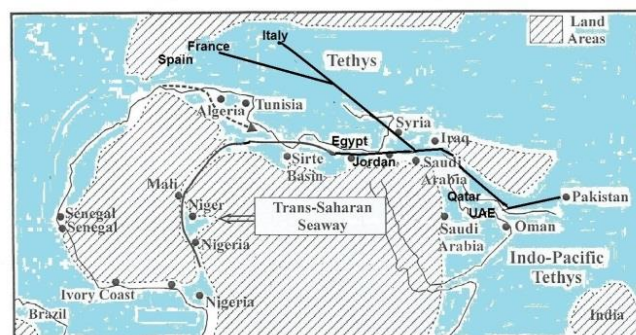


Figure 2: Paleocene paleogeographic map of the Southern Tethys: West Africa (Nigeria) and Southwest Asia (Pakistan, UAE, Qatar, Iraq), and also Northern Tethys (Italy, France) showing possible migration routes of the representatives of the genus *Ornatanolina* Haque (Morsi et al., 2008).

Ornatanolina pakistanica Anan n. sp. - (Pl. 1, figure 8a, b)

1960 *Ornatanolina* cf. *geei* Haque, p. 40, pl. 2, figure 1.

Holotype: Illustrated specimen in Pl. 1, figure 8a, b.
Dimension: Length 34 mm, width 20 mm.
Etymology: After the state of Pakistan.
Type locality: From sample KSR-5, Sor Range, Quetta District, West Pakistan.

Age: Early Eocene.

Depository: Geological Survey of Pakistan (GSP).

Diagnosis: This Middle Eocene species was recorded originally from Pakistan. It is characterized by its discoidal test, 5-7 chambers weakly trochospiral in the early stage and later planispiral, rounded periphery, surface with spiraling costae that interrupted near the depressed sutures at the edges of the chamber surface, aperture interiomarginal and equatorial, round opening with imperforated limbate border.

Remarks: The *O. pakistanica* n. sp. species differs from *O. geei* by its spiraling costae (instead of ribs) that flush with the surface (not raised),

sharply angled interrupted near the depressed sutures at the edges of the chamber surface (not at the radial median ridges), round opening aperture (not slit-like aperture), and recorded in a younger stratigraphic level in the Early Eocene than the Late Paleocene of *O. geei*.

***Ornatomalina ? pustulosa* Haque, 1960 - (Pl. 1, figure 9a, b)**

1960 *Ornatomalina ? pustulosa* Haque, p. 40, pl. 2, figure 2.

Remarks: This species differs from another species of Haque, by its pustules covering the early chambers of the twisted test, but spiraling ribs covers the last two chambers of the last whorl, aperture large round opening, interiomarginal and equatorial, with imperforated limbate border. Morphologically, this species is considered here as a transition from between the two genera: *Saudella* (with pustule in the early stage) and *Ornatomalina* (with the spiraling ribs in the end stage of coiling). The *Ornatomalina ? pustulosa* most probably the ancestor of *Saudella ornata* (Hasson, 1985).

Genus *Thalmanita* Bermúdez, 1952

Type species *Rotalia madrugensis* (Cushman and Bermúdez, 1947)

***Thalmanita madrugensis* (Cushman and Bermúdez, 1947) - (Pl. 1, figure 10a, b)**

1947 *Rotalia madrugensis*, p. 24, pl. 5, figure 4. (Cushman and Bermúdez, 1947)

1951 *Rotalia madrugensis* - Cushman, p. 55, pl. 15, figure 12 (Cushman and Bermúdez, 1951).

1964 *Thalmanita madrugensis* (Cushman & Bermúdez) - p. C621, figure 494. 1 (Loeblich and Tappan, 1964).

2020 *Thalmanita madrugensis* (Cushman and Bermúdez) - p. 56, fig. 27. 1-M (Serra-Kiel et al., 2020).

Remarks: Loeblich and Tappan placed Haque's genus *Ornatomalina* in synonymy with *Thalmanita*, but these authors in considered both genera are separate (Loeblich & Tappan (1964). The test of the species *T. madrugensis* has medium size, strongly biconvex but with the central areas of both sides slightly depressed, periphery broadly rounded; chambers about 10 in the adult whorl, increasing in size rather rapidly as added, earlier ones indistinct; sutures indistinct in the early chambers but depressed, become increasingly depressed in the last chambers; wall strongly ornamented with longitudinal costae confined to each chamber, almost papillate, ventral side with several large papillae in the umbilical area; aperture a low opening of the last-formed chamber, toward the periphery.

Genus *Saudella* (Hasson, 1985)

Type species *Saudella rugosa* (Hasson, 1985)

***Saudella ornata* (Hasson, 1985) - (Pl. 1, figure 11a, b)**

1985 *Saudella ornata* Hasson, p. 348, pl. 1, figs. 6-9.

Remarks: Hasson erected her new genus *Saudella* which is differentiated by its compressed, oval outline, nearly evolute coiling, lack of zigzag ridges across the chambers and a smooth apertural face (Hasson, 1985). The species *S. ornata* has nearly planispiral compressed test, dorsal side evolute, eleven chambers visible in the last whorl increasing gradually in size, ornamentation of heavy pustules covering both sides of test, periphery rounded in later chambers and blunt in earlier part of test, apertural face smooth bordered by a raised imperforate rim. It was recorded also from Early Eocene of Umm er Radhuma Formation in the Rub'al Khali Basin wells, Saudi Arabia (SA).

3. PALEOGEOGRAPHY

A wider Tethyan connections, as far as the Carpathian and Pakistan was suggested, which means that the ancestral Tethys is connected with the ancestral Indian Oceans via Mediterranean Sea (Anan, 2019; Haynes and Nwabufo-Ene, 1998). The record of an unknown species of the genus *Ornatomalina*, in cross sections from Iraq (figure 10), and also from Italy (p. 141, pl. 3, figures 10-12) expands the paleogeographic distribution of the genus into the Southern Tethys (Pakistan, UAE, Qatar, Iraq and Nigeria) and also Northern Tethys (Italy and France) (Johannes et al., 2008). This study proved that the paleogeographic distribution of the Pakistanian genus *Ornatomalina* and its species are expanded into many different parts of the Tethys: UAE, Qatar, Iraq and Nigeria (Southern Tethys) and also Italy and France (Northern Tethys), which contradict what previously noted by some authors that this genus appear to be endemic to Pakistan.

4. PALEOENVIRONMENT

Due to the high abundance of pelagic Pakistanian foraminiferal assemblage indicate open connections to the Tethys and represents middle-outer neritic environment (100-200 m depth) and shows an affinity with "Midway-Type Fauna", while in some horizons the occurrence or increasing abundance of larger foraminiferal specimens interpreted to indicate shallow-marine waters, a maximum depth limit of 35 meters, as also was previously noted by Gohrbandt (1967) that the nummulitic limestone suggesting shallower conditions (Berggren and Aubert, 1975; Gibson, 2007). The deepening paleobathymetric trend in the western Salt Range of Pakistan may be a result of eustatic sea-level change in the latest Paleocene, localized tectonic downwarp, or a more regional downwarp (Gibson, 2007). The identified species shows an affinity with the MTF middle-outer neritic environment (50-200 m), except some horizons suggesting shallower conditions which yield some larger foraminifera.

5. CONCLUSION

The present study deals with the recording of six identified species of the Rotaliid genus *Ornatomalina* of Haque (*O. acuta*, *O. crookshanki*, *O. elegantula*, *O. geei*, *O. glaessneri*, *O. hafeezi*), as well as *O. ennakhali* Anan, *O. pakistanica* n. sp. and also *Ornatomalina ? pustulosa* in seven localities in the Southern and Northern Tethys (Pakistan, UAE, Qatar, Iraq, Nigeria, Italy and France). Most of these species are confined, so far, to Pakistan, except *O. ennakhali* in UAE. *O. hafeezi* was recorded in wide geographical distribution in Asia (Pakistan, Qatar) and west Africa (Nigeria).

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