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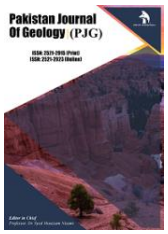

REVIEW ARTICLE

GEOGRAPHIC DISTRIBUTION OF THE OF THE TETHYAN MEMBERS OF THE PALEOGENE-NEOGENE ROTALIID GENUS *ANGULOGERINA*

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ABSTRACT

Twenty-one small Paleocene-Pliocene Rotaliid benthic foraminiferal species of the genus *Angulogerina* are distributed in some localities in the Northern Tethys (USA, Atlantic Ocean, England, Spain, France, Belgian, Germany, Sweden, Poland, Hungaria, Slovenia), and also Southern Tethys (Pakistan, Japan, New Zealand, Argentina and Chile). The modern taxonomic consideration of the recorded species are presented. These species are: *Angulogerina abuzeidi* Anan n. sp., *A. angulosa*, *A. byramensis* , *A. cooperensis*, *A. cuneata*, *A. dubia*, *A. elongata*, *A. europaea*, *A. germanica*, *A. globosa*, *A. japonica*, *A. muralis*, *A. oligocenica*, *A. pulchella*, *A. reussi*, *A. rugoplicata*, *A. sagriniformis*, *A. tenuistriata*, *A. tortuosa*, *A. vicksburgensis* and *A. wilcoxensis*. One of these illustrated species re believed to be new: *Angulogerina abuzeidi* Anan n. sp. The prominent environment of the genus *Angulogerina* and its members most probably in an open outer shelf-upper-middle slop marine environment during the Paleogene-Neogene.

KEYWORDS

Angulogerina, Rotaliid Benthic Foraminifera, Tethys, USA, South America, Europe, Asia, Australia.

1. INTRODUCTION

Twenty one diagnostic species of Rotaliid benthic foraminiferal genus *Angulogerina* were recorded and described from wide localities in the Tethys: North and South America, Europe, south Asia and southeast Pacific Ocean (Figure 1). Eight species of the assemblage were recorded from USA, 5 France, 3, Germany and Slovenia, 2 Atlantic Ocean and Belgian, one species from each of Spain, Sweden, Poland, Hungaria, Pakistan, Japan, New Zealand, Chile and Argentina.

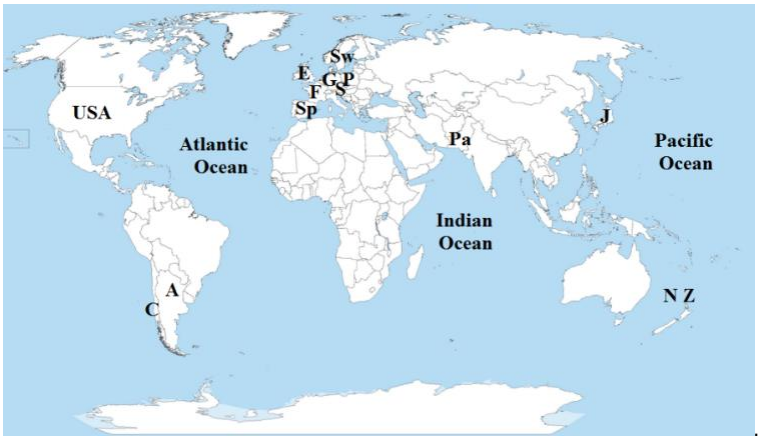

Figure 1: The geographic distribution of the genus's members *Angulogerina* in some countries in the world: North America (USA=United States of America), South America (C=Chile, A=Argentina), Europe (E=England, Sp=Spain, F=France, G=Germany, S=Slovenia, P=Poland, Sw=Sweden), Asia (Pa=Pakistan, J=Japan, N Z =New Zealand).

2. MATERIAL OF STUDY

Well preserved twenty one Rotaliid benthic foraminiferal species of the genus *Angulogerina* were erected from fifteen countries in Northern and Southern Tethys made it possible to elucidate them with its modern taxonomical consideration, following the Code of Zoological Nomenclature (CZN). The taxonomic revision of the assemblage are detect its morphological features, and one species of them is considered here as a new: *Angulogerina abuzeidi*.

3. TAXONOMY

The classification of Loeblich and Tappan (1988) is followed in this study The genus *Angulogerina* is characterized by elongate calcareous, finely perforate triangular triserial test, carinate angles, curved and slightly depressed sutures, smooth surface or with a few widely spaced

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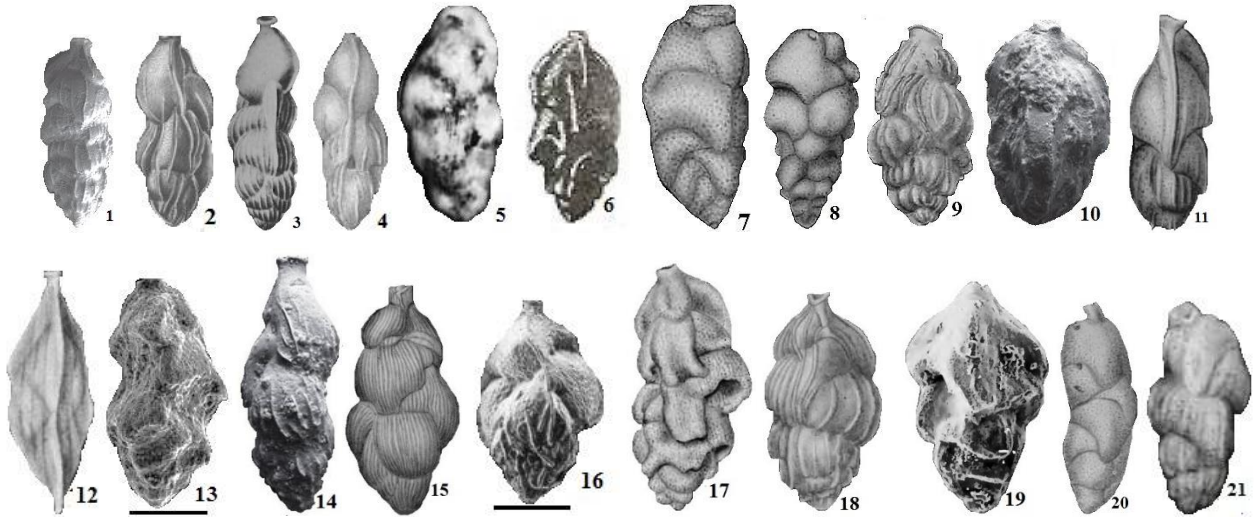
longitudinal costae that may be continuous over the sutures or not, aperture terminal ovate and produced on a neck which bordered by a narrow lip. The two genera *Angulogerina* and *Trifarina* have triserial early stage, but the latter genus *Trifarina* has later followed by distinctly uniserial rectilinear, sharply triangular test in section, with only smooth surface. The twenty one identified species are illustrated in Plate 1.

Plate 1: Figure. 1: *Angulogerina abuzeidi* Anan, n. sp., **2.** *A. angulosa* (Williamson, 1858), **3.** *A. byramensis* (Cushman,1922), **4.** *A. cooperensis* Cushman (1935)**, 5.** *A. cuneata* Brotzen (1948), **6.** *A. dubia* Haque (1960), **7.** *A. elongata* (kalkyard, 1919), **8.** *A. europaea* Cusbman and Edwards (1937)**, 9.** *A. germanica* Cushman and Edwards (1937)**, 10.** *A. globosa* (Stoltz, 1925), **11.** *A. halkayardi* Cushman and Edwards (1937)**, 12.** *A. japonica* Asano (1938)**, 13.** *A. muralis* (Terquem, 1882), **14.** *A. oligocenica* (Andreae, 1894), **15.** *A. pulchella* Cushman and Edwards (1937), **16.** *A. reussi* (Cushman, 1913), **17.** *A. rugoplicata* Cushman (1935)**, 18.** *A. tenuistriata* (Reuss, 1870), **19.** *A. tortuosa* Hornibrook (1961), **20.** *A. vicksburgensis* Cushman (1935), **21.** *A. wilcoxensis* (Cushman and Ponton, 1932) (Scale bars 100 µm).



1. *Angulogerina abuzeidi* Anan n. sp. (=*Angulogerina* cf. *angulosa* (Williamson, 1848) - Pirkenseer et al., 2010, p. 72, pl. 8, fig.10). Rupelian, France.

Holotype: Plate 1, Figure 1.

Etymology: after the Prof. Mohammad Abu Zeid, Geology Dept., Ain Shams University, Cario, Egypt.

Stratigraphic level: Late Rupelian, C39340 (Figure. 2).

Diagnosis: Test elongate calcareous finely perforate, triserial and triangular throughout, angles carinate, sutures curved and depressed, surface with a few widely spaced longitudinal costae that not be continuous over the sutures, aperture terminal and produced on a neck and bordered by a narrow lip.

Remarks: This species has shorter test than *A. angulosa*, and the longitudinal costae continuous cross over the sutures.

1. *Angulogerina angulosa* (Williamson, 1858), p. 67, pl. 5, fig. 140. Miocene, England, Chile, A. Ocean.
2. *Angulogerina byramensis* (Cushman,1922), p. 95, pl.18, fig. 5. Rupelian,USA
3. *Angulogerina cooperensis* Cushman, 1935, p. 42, pl. 16, fig. 9. Eocene, USA.
4. *Angulogerina cuneata* Brotzen, 1948, p. 64, pl.6, fig.10. Paleocene-Eocene, Argentina, Sweeden, Poland.

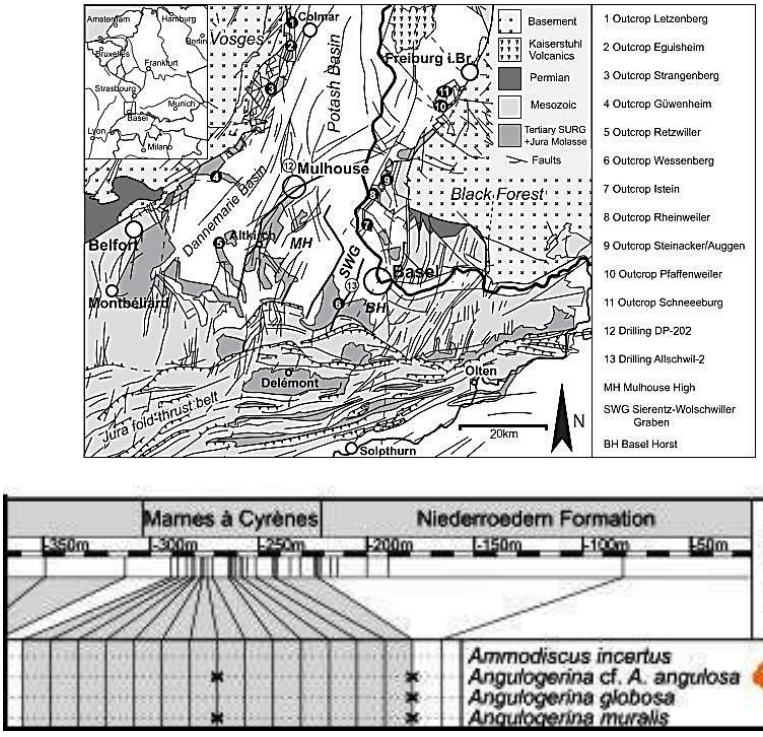


Figure 2. Location map of Upper Rhine Graben in the west Europe, and stratigraphic range of the *A. abuzeidi* n. sp., Late Rubelian (after Pirkenseer et al., 2010).

5. *Angulogobia dubia* Haque, 1960, p. 28, pl. 3, fig. 9. Eocene, Pakistan.

6. *Angulogerina elongata* (kalkyard, 1919), p. 44, pl. 3, fig. 9. Eocene, France, Hungaria.

7. *Angulogerina europaea* Cusbman and Edwards, 1937, p. 61, pl. 8, figs. 17, 18. Eocene, France.

8. *Angulogerina germanica* Cushman and Edwards, 1937, p. 85, pl. 15, figs, 14.16. Eocene, USA.

9. *Angulogerina globosa* (Stoltz, 1925), p. 130, fig. 2. Eocene, Germany, France Slovenia.

10. *Angulogerina halkayardi* Cushman and Edwards, 1937, p. 60, pl. 8, fig. 14. Eocene, USA.

11. *Angulogerina japonica* Asano, 1938, p. 615, pl. 17, fig. 17. Pliocene, Japan.

12. *Angulogerina muralis* (Terquem, 1882), p. 119, pl. 12, figs. 26-29. Lutetian-Priabonian, Spain, France, Belgian, Slovenia.

13. *Angulogerina oligocenica* (Andreae, 1894), p. 50, text fig. 1. Eocene, Germany.

14. *Angulogerina pulchella* Cushman and Edwards, 1937, p. 61, pl. 8, fig. 19. Eocene, France, Slovenia

15. *Angulogerina reussi* (Cushman, 1913), p. 63, pl. 13, fig. 5. Pliocene, USA, Spain.

16. *Angulogerina rugoplicata* Cushman, 1935, p. 33, pl. 5, fig. 5. Eocene, USA.

17. *Angulogerina tenuistriata* (Reuss, 1870), p. 485, pl. 22, figs. 34-87. Oligocene, Germany.

18. *Angulogerina tortuosa* Hornibrook, 1961, p. 68, pl. 9, figs. 151, 152. Miocene, New Zealand.

19. *Angulogerina vicksburgensis* Cushman, 1935, p. 88, pl. 15, figs. 21, 22. Eocene, USA.

20. *Angulogerina wilcoxensis* (Cushman and Ponton, 1932), p. 66, pl. 8, fig. 18. Eocene, USA, Belgian Basin.

4. Paleogeography

One of the interesting point in a comparison of material from the world, the twenty one recorded species of the genus *Angulogerina* have wide geographic distribution in many parts of the Northern Tethys (particularly USA and Europe), while rarely in Southern Tethys: South America (Chile and Argentina), Asia (Pakistan, Japan) and New Zealand (Table 1), but no data are available of any species of *Angulogerina* had been recorded from Africa. (see Figure. 1).

5. Paleoenvironment

Most recorded species in this study were erected from many countries in the Tethys, which are indicated an open connection of the Tethys and represent fully marine outer shelf to upper bathyal foraminifera assemblages in an open deep marine basin during the Paleogene-Neogene time, which supports the open flow direction of the Tethyan Circumglobal Current (TCC) in all directions (Figure 3).

Figure 3: The Neo-Tethys ocean during the Paleogene-Neogene times showing the open flow direction of the Tethyan Circumglobal Current (TCC) in all directions (after Abed, 2013).

6. Conclusions

The present study deals with the recording of twenty one members of the calcareous Rotaliid foraminifera genus *Angulogerina* were originally erected from many localities in the Northern Tethys (USA and Europe), and alas Southern Tethys (Pakistan, Japan and New Zealand, Chile and Argentina). Some of the identified species are also recorded far than its original erection in other localities in the Tethyan realm, which had been connected with the Atlantic Ocean from west to the Indo-Pacific Ocean to the east, via Mediterranean Sea. Environmental conditions of the identified species represent in an open marine outer shelf-upper-middle slop environment during the Paleogene-Neogene time.

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