

## RESEARCH ARTICLE

# GEOGRAPHIC DISTRIBUTION AND TAXONOMIC CONSIDERATION OF THE SOUTHERN TETHYAN ROTALIID BENTHIC FORAMINIFERAL MEMBERS OF THE GENUS *Anomalinoidea*

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## ABSTRACT

Seventeen *Anomalinoidea* Rotaliid benthic foraminiferal species were erected from five localities in the Southern Tethys Chile, Algeria, Tunisia, Egypt and Pakistan. Thirteen of the identified species were erected from Egypt, and four of the them were erected from Tunisia, while only one species of the assemblage was recorded from the other countries: Chile, Argentina, Algeria, Jordan, UAE, Iran and Pakistan. Three out of the identified species is believed here to be new: *A. dababiyaensis*, *A. masrensis* and *A. tunisica*. Environmental conditions of the identified species of the genus *Anomalinoidea* most probably represent outer neritic-upper bathyal environment.

## KEYWORDS

Paleontology, Stratigraphy, *Anomalinoidea*, benthic foraminifera, Tethys

## 1. INTRODUCTION

The author has examined 17 species belonging to the Rotaliid benthic foraminiferal genus *Anomalinoidea*, which were originally erected from the Southern Tethys: Chile, Algeria, Tunisia, Egypt, Pakistan, and also some of them were recorded from other countries in the Southern Tethys (Figure 1).



*Anomalinoidea* is distinguished by its trochospiral test, may have central boss in spiral side and rounded periphery, aperture a low interiomarginal arch against the periphery of the preceding whorl, extending onto the spiral side with a narrow bordering lip. The genus *Anomalinoidea* differs from the genus *Cibicoides* Thalmann in its biconvex, biumbonate and trochospiral test, limbate curved suture on the spiral side and angular periphery. The type specimen of *Anomalina* was lost, a petition was submitted to the ICZN for suppression of *Anomalina* and retention of *Epistomaroides* as a valid genus.

The present study aims at throwing light on: 1) present together many data scattered in the literature for the different members of this genus

*Anomalinoidea* under a unifying theme, 2) detect its modern taxonomic consideration, stratigraphy, paleogeography and paleoenvironment of them, 3) present a new species: *A. dababiyaensis*, *A. masrensis* and *A. tunisica*.

## 2. MATERIAL OF STUDY

Rich and well-preserved seventeen Rotaliid foraminiferal species of the genus *Anomalinoidea* were erected from some countries from the Southern Tethys (Chile, Algeria, Tunisia, Egypt and Pakistan), and some of them are also recorded in the other localities in the Southern Tethys (e. g. Argentina, Jordan, Saudi Arabia, UAE, Iran). Three of the identified species are believed to be new: *A. dababiyaensis*, *A. masrensis* and *A. tunisica*.

## 3. SYSTEMATIC PALEONTOLOGY

The taxonomy of is followed in this study for the seventeen Maastrichtian-Paleogene Rotaliid benthic foraminiferal species of the genus *Anomalinoidea* were erected from some countries in the Southern Tethys (Chile, Algeria, Tunisia, Egypt and Pakistan), and some of them are also recorded in the other localities in the Southern Tethys (e. g. Argentina, Saudi Arabia, UAE, Iran) (Loeblich and Tappan, 1988). Following the Code of Zoological Nomenclature, a taxonomic revision of the assemblage is used, and three species of them is considered here as a new.

Suborder Rotaliina Delage & Hérouard, 1896

Superfamily Chilostomellacea Brady, 1881

Family Heterolepidae Gonzáles-Donoso, 1969

Genus *Anomalinoidea* Brotzen, 1942

Type species *Anomalinoidea plummerae* Brotzen, 1942

The new taxonomic considerations are used for the recorded species, and illustrated in Plate 1.

## Quick Response Code



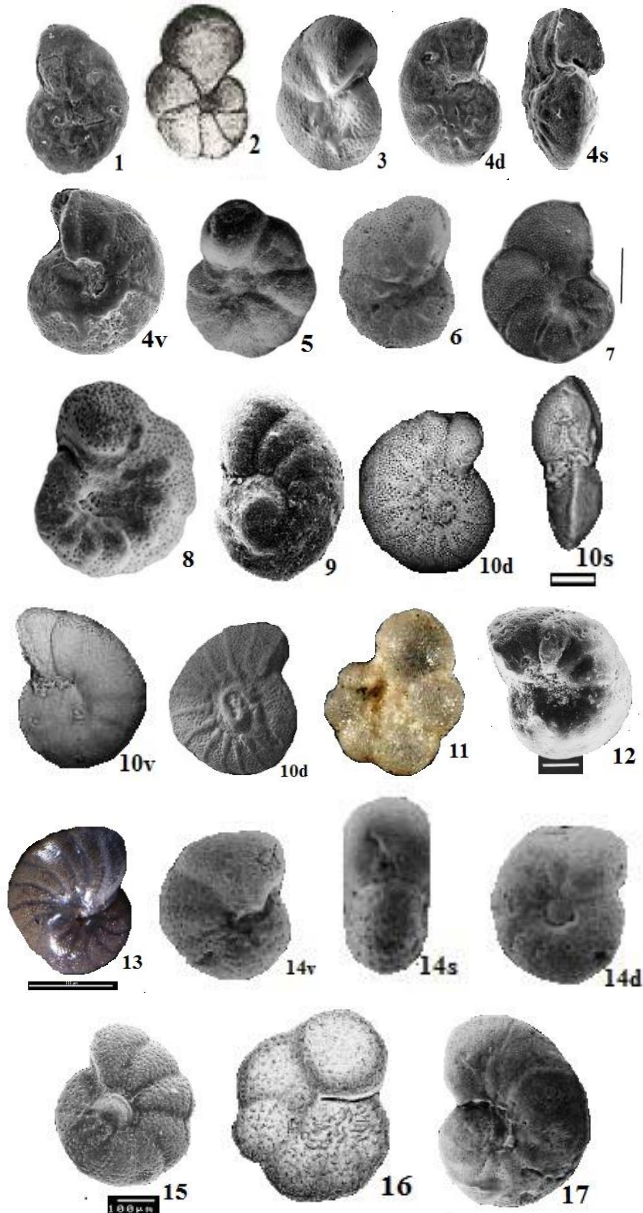
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Plate 1

**Figure 1.** *Anomalinoidea aegyptiacus* (LeRoy, 1953; Alegret and Ortiz, 2007) ①, 2. *A. bandyi* (Haque, 1956) ②, 3. *A. chiliana* (Todd and Kniker, 1952; Jannou, 2009) ③, 4. *A. dababiyaensis* Anan, n. sp. (Alegret and Ortiz, 2007) ④. 5. *A. desertorum* (LeRoy, 1953; Anan, 2008) ⑤, 6. *A. esnehensis* (Nakkady, 1950), 7. *A. fayoumensis* (Ansary, 1955; after Anan, 2010) ⑥, 8. *A. leroyi* Anan, 2008 ⑦, 9. *A. lordi* Bou Dagher, 1988 ⑧, 10a-c & d. *A. masrensis* Anan, n. sp. (Ayyad et al., 2023) ⑨-11. *A. nakkadyi* (Said and Kenawy, 1956) ⑩, 12. *A. sinaensis* (Said and Kenawy, 1956; Ayyad et al., 1997) ⑪, 13. *A. saturatus* (Said and Kenawy, 1956) ⑫, 14a-c. *A. tunisica* Anan, n. sp. (Speijer, 1994) ⑬, 15. *A. umbonifera* (Schwager, 1883; Orabi and Zaky, 2016) ⑭, 16. *A. vanbelleni* (Ten Dam and Sigal, 1950) ⑮, 17. *A. zitteli* (LeRoy, 1953; Anan, 2008) ⑯ {v. ventral view, s. side view, d. dorsal view} (bar = 100 µm).

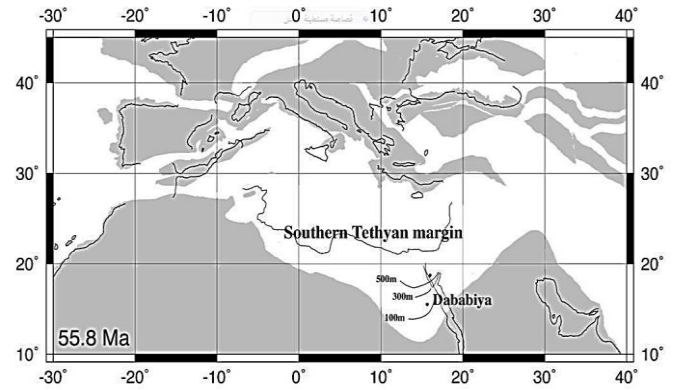


- 1) *Anomalinoidea aegyptiacus* (LeRoy, 1953) (= *Anomalina aegyptiaca* LeRoy, 1953, p.17, pl.7, figs. 21-23). Paleocene-Early Eocene, Egypt. and Tunisia (Speijer, 1994; LeRoy, 1953).
- 2) *Anomalinoidea bandyi* (Haque, 1956) (= *Anomalina bandyi* Haque, 1956, p.191, pl.16, figs.11, 12). Paleocene, Pakistan and Saudi Arabia (Hasson, 1985; Haque, 1956).
- 3) *Anomalinoidea chiliana* (Todd and Kniker, 1952) (= *Anomalina chiliana* Todd & Kniker, 1952, p. 27, pl. 4, fig. 34, after Jannou, 2009, p. 116, fig. 13V). Ypresian, Chile and Argentina.
- 4) *Anomalinoidea dababiyaensis* Anan, n. sp. (= *Anomalinoidea* sp. B Alegret & Ortiz, 2007, p. 438, pl. 1, fig. 17). Ypresian, Egypt.

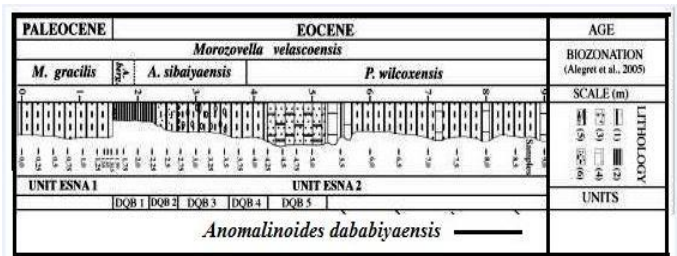
Holotype: Illustrated specimen in Plate 1, Figure 4a-c.

Etymology: After the Dababiya Stratotype section, Egypt.

Type locality: Dababiya section, Southern Tethys (Figure. 2).



**Figure 2:** Paleogeographical reconstruction of Dababiya Quarry section (Alegret and Ortiz, 2007).



**Figure 3.** Stratigraphic range of the new species *A. dababiyaensis*. Stratigraphic level: Ypresian, *P. wilcoxensis* Zone (E2) (Figure. 3).

**Diagnosis:** Test trochospiral, biconvex, subcircular in outline, rounded periphery, ventral side semi-involute, 9 to 11 chambers in the last whorl, separated by distinct, slightly curved, raised sutures, but thickening towards the umbilicus, forming a distinct raised spiral area, dorsal side semi-evolute, sutures distinct, curved and raised, forming a plug, wall calcareous, distinctively perforated on both sides, aperture an arch extending from the periphery onto the ventral side towards the umbilicus.

**Remarks:** This species is characterized by its biconvex test, raised curved sutures on both sides, and rounded periphery. The Paleocene-Ypresian *Anomalinoidea aegyptiacus* (LeRoy) most probably the ancestor of the new Ypresian species *A. dababiyaensis*.

- 5) *Anomalinoidea desertorum* (LeRoy, 1953) (= *Anomalina desertorum* LeRoy, 1953, p.17, pl.7, figs. 18-20). Paleocene-Ypresian, Egypt (LeRoy) and Arabian Sea (Boltovskoy et al., 1993).
- 6) *Anomalinoidea esnehensis* (Nakkady, 1950) (= *Anomalina scrobiculata* (Schwager) var. *esnehensis* Nakkady, 1950, p. 691, pl. 90, figs. 33, 34). Paleocene-Ypresian, Egypt (Nakkady).
- 7) *Anomalinoidea fayoumensis* (Ansary, 1955) (= *Anomalina fayoumensis* Ansary, 1955, p. 123, pl. 4, fig. 10). Ypresian, Egypt Jordan and UAE (Anan 2010; Basha, 2005; Ansary, 1955).
- 8) *Anomalinoidea leroyi* Anan, 2008 (= *Anomalina* sp. K LeRoy, 1953, p.19, pl.3, figs. 26-28; *A. sp. 1*, Speijer, 1994, p. 62, pl. 2, fig. 3). Maastrichtian-Danian, Egypt and Tunisia (Speijer, 1994; LeRoy, 1953).
- 9) *Anomalinoidea lordi* Bou Dagher, 1988, p. 139, pl. 3, figs. 4-10. Ypresian, Tunisia.
- 10) *Anomalinoidea masrensis* Anan, n. sp. (= *Anomalinoidea cf. alazanensis* of Ayyad et al, 2023, fig. 3 v-x), and *A. aff. trinitatensis* (Nuttall) of Salahi, 2021, p. 319, pl. 6, fig. 7a).

Holotype: Illustrated specimens in Plate 1, Figure 10a-c.

Etymology: After the Arab Republic of Egypt (Masr).

Type locality and sample: Wadi EdDakhl section, west Gulf of Suez, Egypt, sample 20 (Figure. 4). Stratigraphic level: Ypresian.

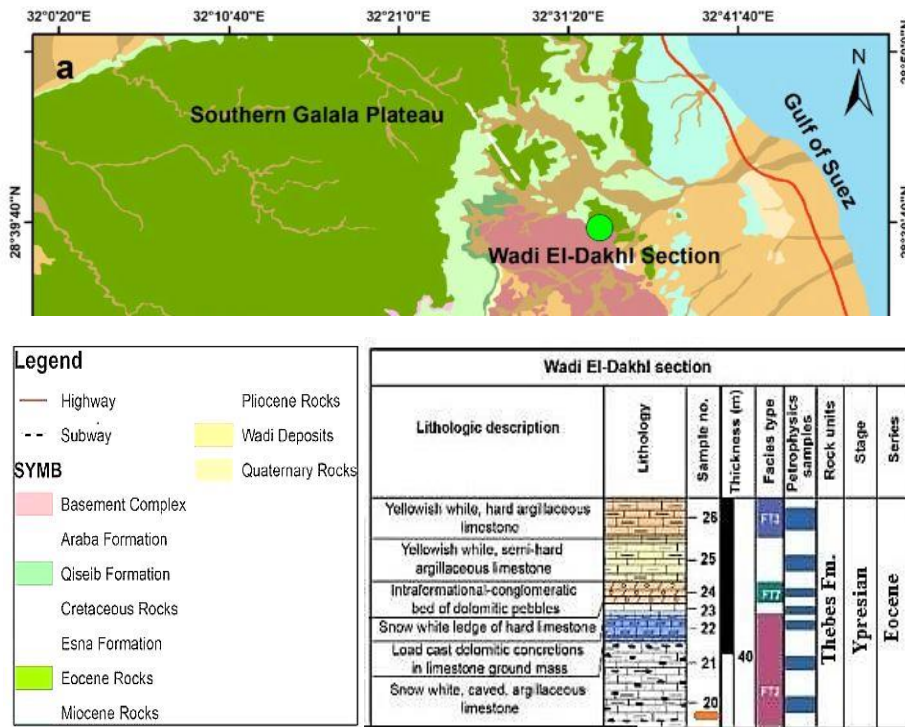


Figure 4: Location and stratigraphic log of Wadi EdDakhl section, west Gulf of Suez, Egypt.

Diagnosis: Test biconvex trochospiral species, semi-circular in outline, rounded periphery, about 15 chambers in the last whorl, perforated surface, sutures are limbate raised, and more strongly towards the umbilicus, aperture an arch extending from the periphery onto the ventral side towards the umbilicus.

Remarks: It seems that the figured specimen *A. aff. trinitatensis* (Nuttall) of Salahi (2021, p. 319, pl. 6, figure. 7a) from Iran is identical with the new species *A. masrensis*. This species is characterized by its perforated surface and raised limbate sutures.

11) *Anomalinoides nakkadyi* Said & Kenawy, 1956 p. 154, pl. 7, fig. 1. Maastrichtian, Egypt (Said and Kenawy, 1956).

12) *Anomalinoides sinaensis* Said & Kenawy, 1956, p.154, pl. 7, fig. 3.

Maastrichtian, Egypt (Said and Kenawy, 1956).

13) *Anomalinoides suturatus* Said & Kenawy, 1956, p.154, pl. 7, fig. 2. Maastrichtian, Egypt (Said and Kenawy, 1956).

14) *Anomalinoides tunisica* Anan, n. sp. (= *Anomalinoides* sp. 2 Speijer, 1994, p. 62, pl. 6, figures. 2-4).

Holotype: Illustrated specimen in Plate 1, Figure 13.

Etymology: After the Republic of Tunisia, west North Africa (Fig.5A).

Type locality and sample: El Kef section, sample SN 136 (Fig. 5B).

Stratigraphic level: Maastrichtian.

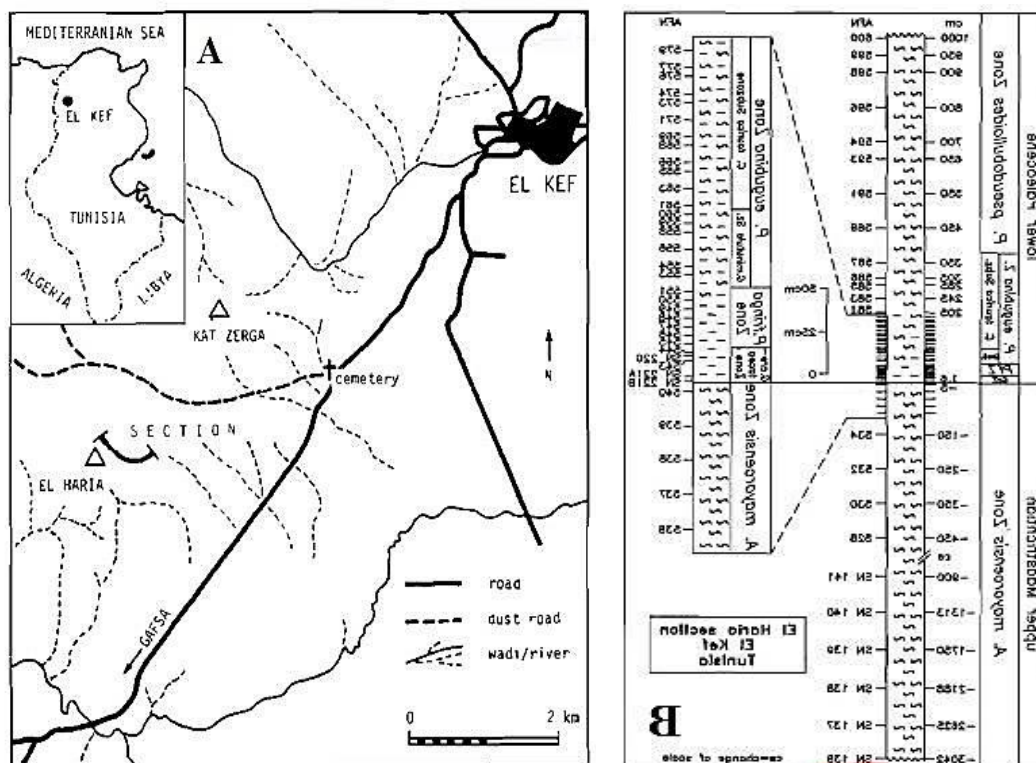


Figure 5: A,B. Location map of the El Kef section, type locality and sample of the new species *A. tunisica* (Speijer, 1994).

Diagnosis: Test small biumbilicate trochospiral species, subcircular in outline, rounded periphery, about 10 chambers in the last whorl, slightly straight depressed sutures in the last chambers, small apertural flaps enable distinction between the two sides.

Remarks: It is characterized by its biumbilicate test, rounded periphery and apertural flaps.

15) *Anomalinoidea umbonifera* (Schwager, 1883)(=*Discorbis praecursoria* var. *umbonifera* Schwager, 1883, p. 126, pl. 27, fig. 14). Maastrichtian-Ypresian, Egypt.

16) *Anomalinoidea vanbelleni* Ten Dam & Sigal, 1950, p. 36, pl. 2, fig. 26.

Paleocene, Algeria and Egypt (Said and Kenawy, 1956; Ten Dam and Sigal, 1950).

17) *Anomalinoidea zitteli* (LeRoy, 1953)(=*Cibicides zitteli* LeRoy, 1953, p. 25, pl. 6, figs. 20-22). Paleocene-Ypresian, Egypt (LeRoy, 1953).

4. PALEOGEOGRAPHY

According to many authors the Tethys had been connected from west Atlantic Ocean to east with the Indian Ocean via the Mediterranean Sea during the Maastrichtian-Paleogene time (Rögl, 1999; Abed, 2013; Anan, 2020). The identified species have wide stratigraphic distribution from many parts of the Southern Tethys (Table 1).

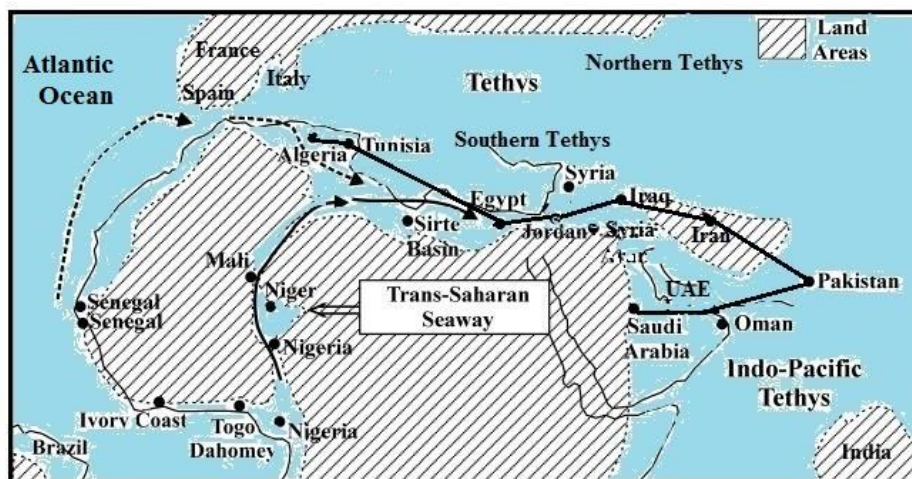
**Table 1:** The paleogeographic distribution of the identified species of the genus *Anomalinoidea* in the Tethys: C=Chile, A=Argentina, G=Algeria, T=Tunisia, E=Egypt, J=Jordan, S=Saudi Arabia, U=UAE, I=Iran, P=Pakistan (Sp. no. = species number, O=illustrated species, x = recorded species).

Sp. no.	CountriesSpeciesof <i>Anomalinoidea</i>	C	A	G	T	E	J	S	U	I	P
1	<i>aegyptiacus</i>				x	O					
2	<i>bandyi</i>							x			O
3	<i>chileana</i>	O	x								
4	<i>dababiyaensis</i>					O					
5	<i>desertorum</i>					O					
6	<i>esnehensis</i>					O					
7	<i>fayoumensis</i>					O	x		x		
8	<i>leroyi</i>				x	O					
9	<i>lordi</i>				O						
10	<i>masrensis</i>					O				x	
11	<i>nakkadyi</i>					O					
12	<i>sinaensis</i>					O					
13	<i>suturatus</i>					O					
14	<i>tunisica</i>				O						
15	<i>umbonifera</i>					O					
16	<i>vanbelleni</i>			O		x					
17	<i>zitteli</i>					O					

The seventeen small benthic foraminiferal species belong to the diagnostic calcareous Rotaliid benthic foraminiferal genus *Anomalinoidea* were identified from some localities in the Southern Tethys (Chile, Argentina, Algeria, Tunisia, Egypt, Jordan, Saudi Arabia, UAE, Iran, Pakistan) (Figure 6). Some remarks of the paleogeographic distribution of the recorded species can be added:

1. Thirteen of the identified species were erected from the Southern Tethys, Egypt: 13/17 (about 76.5 %).
2. Four of the identified species were erected from Tunisia 4/17 (about 23.5 %).

3. One species from the other countries: Chile, Argentina, Algeria, Jordan, UAE, Iran, Pakistan: 1/17 (about 0.05 %).
4. *A. fayoumensis* is recorded from three localities in the Southern Tethys (see Table 1).
5. *A. aegyptiacus*, *A. chileana*, *A. leroyi*, *A. masrensis*, *A. vanbelleni* are recorded in two countries in the Southern Tethys.
6. *A. dababiyaensis*, *A. desertorum*, *A. esnehensis*, *A. lordi*, *A. nakkadyi*, *A. sinaensis*, *A. suturatus*, *A. tunisica*, *A. umbonifera*, *A. zitteli* are, so far, an endemic to their original erection.

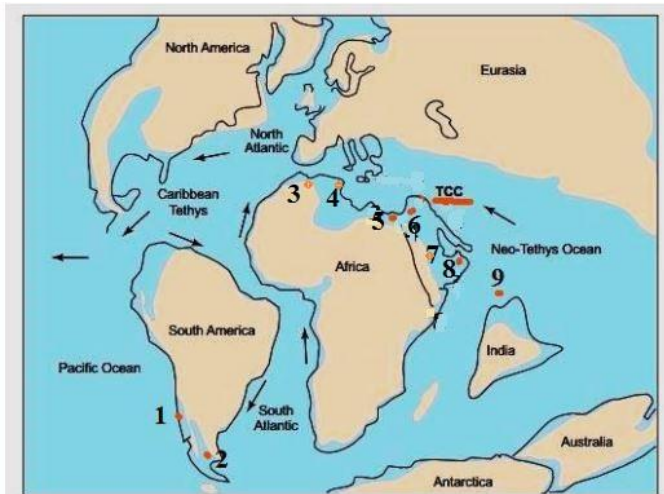


**Figure 6:** The paleogeographic map at K/T boundary showing the connected seas from west (Atlantic Ocean) to east (Indian and Pacific Oceans) via the Mediterranean Sea, Southern Tethys, including (Algeria, Tunisia, Egypt, Jordan, Saudi Arabia, Iraq, Iran, UAE, Pakistan) (after Morsi et al, 2008).

## 5. PALEOENVIRONMENT

Most recorded species in this study were erected from some countries in the Southern Tethys (Algeria, Tunisia, Egypt and Pakistan), as well as, other countries in the Southern Tethys (Chile, Argentina, Jordan, Saudi Arabia, Iran), which indicated open connection of the Tethys and represent outer neritic-upper bathyal environment (Kouwenhoven et al, 1997). The flow of the New Tethys Ocean and its continuation

In the Mediterranean Sea to the North Atlantic and to tropical the Caribbean-Gulf Coast region to the Pacific Ocean and South Atlantic (Figure 7).



**Figure 7:** Paleogeography of the Neo-Tethys Ocean during the K/T showing the flow direction of the Tethyan Circumglobal Current (TCC) from east to west to south: 1. Chile, 2. Argentina, 3. Algeria, 4. Tunisia, 5. Egypt, 6. Jordan, 7. Saudi Arabia, 8. UAE, 9. Pakistan with some modifications (Abed, 2013).

## 6. CONCLUSIONS

The present study deals with the recording of seventeen identified species of the calcareous Rotaliid foraminifera genus *Anomalinoidea* were originally erected from some localities in the Southern Tethys (Chile, Algeria, Tunisia, Egypt and Pakistan). Some of the identified species are also recorded far than its original erection in other localities in the South America (Argentina), and Southern Tethys (Jordan, Saudi Arabia, UAE and Iran). The Tethyan realm had been connected with the Atlantic Ocean from west to the Indo-Pacific Ocean to the east, via Mediterranean Sea, which crossing the Middle East region during the Maastrichtian-Paleogene time. Environmental conditions of the identified species represent outer neritic-upper bathyal environment.

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