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RESEARCH ARTICLE

GEOGRAPHIC DISTRIBUTION OF THE SOUTHERN TETHYAN MEMBERS OF THE ROTALIID GENUS *GYROIDINOIDES*

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ABSTRACT

Eleven Upper Cretaceous-Paleogene small Rotaliid benthic foraminiferal species of the genus *Gyroidinoides* are distributed in some localities in the Southern Tethys (Tunisia, Egypt, Côte d'Ivoire-Ghana Transform Margin, Tanzania, Jordan, Pakistan, New Zealand). The taxonomic consideration of the identified species are presented These species are: *Gyroidinoides aegyptiaca* , *G. africana* Anan, n. sp., *G. brotzeni* , *G. frizzelli* , *G. luterbacher* , *G. reussi* , *G. sarwari* , *G. tayyabi* , *G. tellburmaensis* , *G. tunisica* Anan, n. sp., *G. zelandica* . Two of these illustrated species of Côte d'Ivoire-Ghana Transform Margin and Tunisia are believed to be new: *G. africana* and *G. tunisica*. The prominent environment of the genus *Gyroidinoides* its members most probably are ranged from the Outer shelf – Upper-middle bathyal-abyssal environment.

KEYWORDS

Gyroidinoides, Rotaliid Benthic Foraminifera, Upper Cretaceous, Paleogene, Southern Tethys

1. INTRODUCTION

Eleven diagnostic species of Upper Cretaceous-Paleogene Rotaliid benthic foraminiferal genus *Gyroidinoides* were recorded and described from wide sites in the Southern Tethys: North Africa, Central Africa, southeastern Asia and southeast Pacific Ocean (Figure 1). Five species of the assemblage were recorded from Egypt: *Gyroidinoides aegyptiaca*, *G. brotzeni*, *G.frizzelli*, *G. luterbacheri* Anan, *G. reussi*, two species from Pakistan *G. sarwari* and *G. tayyabi*, one species from each of Tunisia (*G. tunisica*, n. sp.), Côte d'Ivoire-Ghana Transform Margin and Tanzania (*G. africana*, n. sp.), Jordan (*G. tellburmaensis*, New Zealand *G. zelandica* (Said and Kenawy, 1956; Futyan, 1976; Haque, 1960; Haque, 1956; Anan, 2004; Said and Kenawy, 1956; Ansary, 1955; Finlay, 1939).

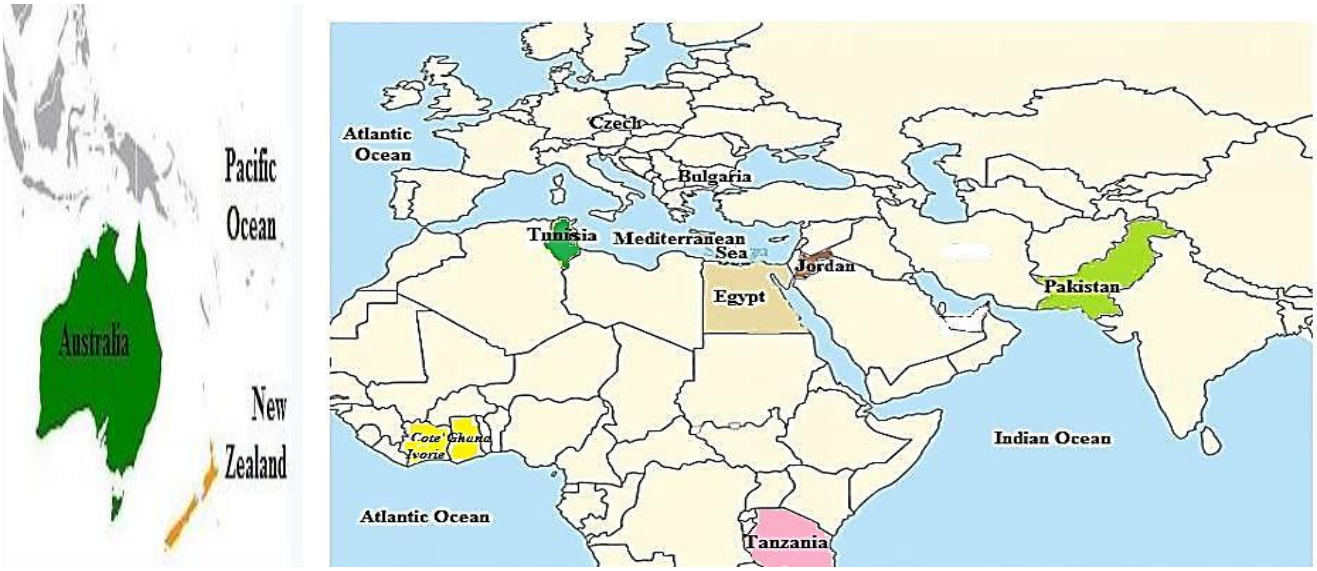

Figure 1: The paleogeographic map of some Southern Tethyan countries (Côte d'Ivoire-Ghana Transform Margin, Tanzania, Tunisia, Egypt, Jordan, Pakistan and New Zealand), which the recognized Maastrichtian-Paleogene members of the genus *Gyroidinoides* were recorded.

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2. Material Of Study

Well preserved eleven Rotaliid benthic foraminiferal species from seven countries in Southern Tethys (Tunisia, Egypt, Côte d'Ivoire-Ghana Transform Margin and Tanzania, Egypt, Jordan Pakistan and New Zealand), made it possible to elucidate them with its modern taxonomical consideration, following the Code of Zoological Nomenclature (CZN). The taxonomic revision of two species of them are re-described its morphological features, which considered here as a new species :*Gyroidinoides africana* and *Gyroidinoides Tunisica.*

3. Taxonomy

The classification is followed in this study of (Loeblich and Tappan, 1988). The genus *Gyroidinoides* is characterized by its smooth biconvex trochospiral test, evolute and faintly convex spiral side, but involute and highly convex umbilical side, umbilicus open but partially obscured by an umbilical apertural flap, sutures radial and very slightly curved, periphery mainly rounded, wall calcareous and perforate, aperture a low interiomarginal slit extending from the periphery to the umbilicus, and may remain open in the umbilicus. The eleven identified species are illustrated in Plate 1.

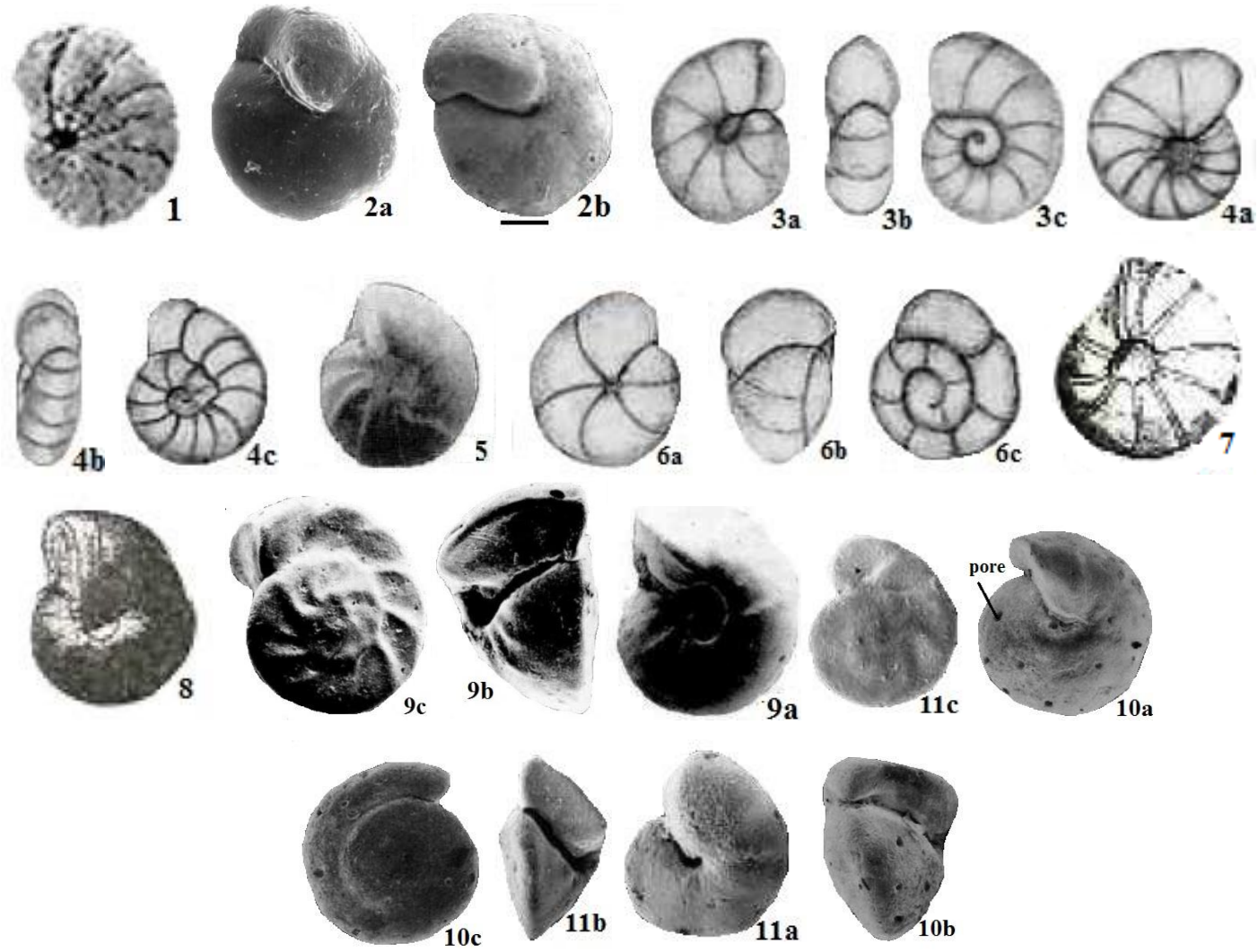

Plate 1

(vv= ventral view, sv. Side view, dv=dorsal view, p=pore, x bar=100μm)

Figure 1: *Gyroidinoides aegyptiaca*, Egypt; **2a,b.** *G. africana* Anan, n. sp., a. Tanzania, b. Côte d'Ivoire-Ghana Transform Margin; **3a-c.** *G. brotzeni*, Egypt; **4a-c.** *G. frizzelli*, Egypt; **5.** *G. luterbacheri* Anan, Egypt; **6a-c.** *G. reussi*, Egypt; **7.** *G. sarwari*, Pakistan; **8.** *G. tayyabi*, Pakistan; **9a-c.** *G. tellburmaensis* Futyan, Jordan; **10a-c.** *G. tunisica* Anan, n. sp., Tunisia; **11a-c.** *Gyroidinoides zelandica*, New Zealand (Ansary, 1955; Finlay, 1939; Anan, 2004; Said and Kenawy, 1956; Haque, 1956; Haque, 1960; Futyan, 1976).

Family Gavelinellidae Hofker, 1956

Subfamily Gyroidinoidinae Saidova, 1981

Genus *Gyroidinoides* Brotzen, 1942

Type species *Rotalia nitida* Reuss, 1844

***Gyroidinoides aegyptiaca* (Ansary, 1955)** *(=Gyroidina aegyptiaca* Ansary, Ansary, 1955, p. 106, pl. 3, fig. 25), Eocene, Egypt.

2a,b. *Gyroidinoides africana* Anan, n. sp., a. Côte d'Ivoire-Ghana Transform Margin, b. Tanzania.

Holotype: Plate 1, Figure 2a

Paratype: Plate 1, Figure 2b.

Etymology: a. after the Côte d'Ivoire-Ghana Transform Margin, central west Africa, Gulf of Guinea, Atlantic Ocean (Figure 2), b. after the state of Tanzania, East Africa (Figure 3).

Type locality and sample: a. Sample 159-959D-66R-1, 68–71 cm, b. Sample TDP 9/4-1, 61-64 cm.

Stratigraphic level: Coniacian-Maastrichtian.

Diagnosis: The species has smooth biconvex trochospiral test, highly convex umbilical side, sutures very slightly curved, periphery rounded, umbilicus closed, aperture a low interiomarginal tight slit extending from the periphery to the umbilicus.

Remarks: In Côte d'Ivoire-Ghana Transform Margin the holotype was recorded from Coniacian to early Santonian. In Tanzania was recorded from Campanian-Maastrichtian. Moreover, the holotype differs from the paratype by diagnostic lip on the aperture.

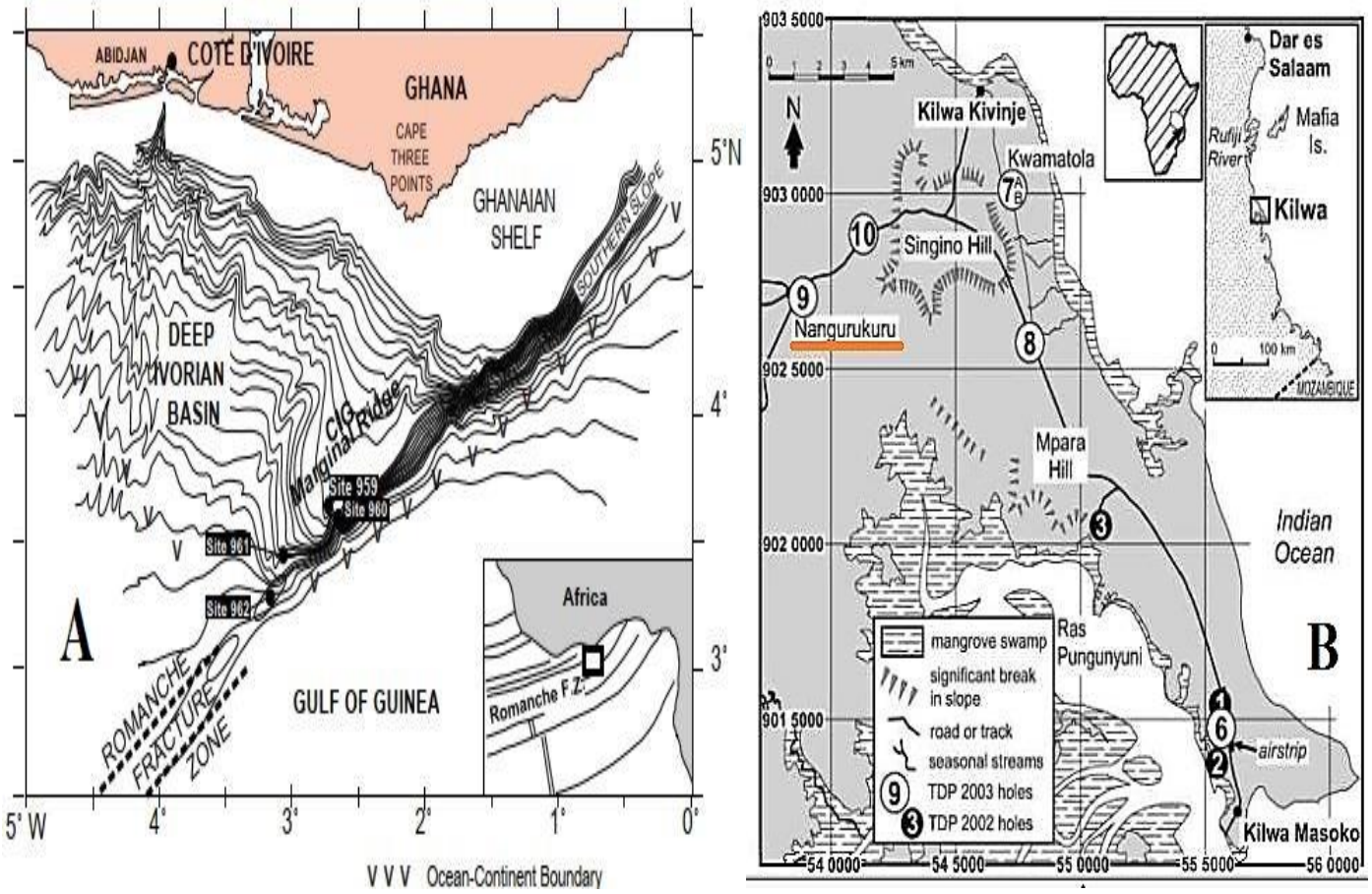

Figure 2: (A)Map of the Côte d'Ivoire-Ghana Transform Margin (central west Africa, Gulf of Guinea, Atlantic Ocean), (B) Map of the Kilwa study area on the Southern Tanzanian coast, showing the drill sites and the stratigraphic range of the *Gyroidinoides africana* Anan, n. sp. in TDP 9 (Pearson et al., 2006; Holbourn and Kuhnt, 1998).

Gyroidinoides brotzeni (=*Gavelinella brotzeni* Said and Kenawy, 1956, p. 147, pl. 4, fig. 47). Maestrichtian, Egypt (Said and Kenawy, 1956).

Remarks: The species is characterized by its open umbilicus, and the aperture on the ventral side extending from the periphery to the umbilicus but extending dorsally between the last two whorls.

Gyroidinoides frizzelli**,** p. 149, pl. 5, fig. 13. Paleocene, Egypt (Said and Kenawy, 1956).

Remarks: The species is characterized by its compressed test, eleven or twelve chambers in the last-formed whorl, and wide open umbilicus.

Gyroidinoides luterbacheri**,** p. 49, pl. 1, fig. 13. Paleocene, Egypt (Anan, 2004).

Remarks: This species characterized by its wide but without deep umbilicus, aperture slit-like, extending from umbilicus to the dorsal edge along the base of the broad apertural face.

Gyroidinoides reussi (=*Gyroidina reussi* Said & Kenawy, 1956, p. 149, pl. 5, fig. 10). Paleocene, Egypt and United Arab Emirates (UAE) (Said and Kenawy, 1956).

Remarks: This species characterized by only the six chambers of the final whorl visible on the more convex ventral side, broadly rounded periphery, aperture a low slit at the base of the last chamber.

Gyroidinoides sarwari (=*Gyroidina girardana* (Reuss) var. *limbata* Haque, 1956, p. 150, pl. 27, fig. 3; *Gyroidina girardana sarwari* Haque-Thalmann, 1959, p. 130). Paleocene, Pakistan (Haque, 1956).

Remarks: This species characterized by open wide umbilicus, and radial limbate raised sutures.

Gyroidinoides tayyabi (=*Gyroidina tayyabi* Haque, 1960, p. 29, pl. 4, fig. 6). Eocene, Pakistan (Haque, 1960).

Remarks: It has highly convex 10-12 chambers in the umbilical side with open wide umbilicus.

Gyroidinoides tellburmaensis, p. 532, pl. 81, figs. 10-12. Maastrichtian-Danian, Jordan and Tunisia (Futyan, 1976).

Remarks: Anan proposed the Maastrichtian-Danian *G. tellburmaensis* (Futyan) → Thanetian-Ypresian *G. subangulata* lineage, which the former differs from the latter by its more acute periphery, more whorls, wider umbilicus and limbate sutures on spiral side (Anan, 2022; Plummer, 1927). *G. tellburmaensis* also differs from *G. girardanus* by its more angular periphery, raised limbate sutures on the spiral side, and deeply limbate sutures on the ventral side (Reuss, 1851).

Gyroidinoides tunisica **Anan, n. sp., (=***Gyroidinoides* sp. 1, p. 62, pl. 9, fig. 6). Tunisia.

Holotype: Plate 1, Figure 10a-c.

Etymology: after the Republic of Tunisia (Figure 3).

Stratigraphic level: Paleocene.

Diagnosis: This species consists of 2-3 narrow whorls, each with 8-10

chambers, spiral side slightly convex, whereas the umbilical side is conical, sutures entirely flush with the surface, and wall perforated by relatively wide pores.

Remarks: This species is characterized by conical ventral side, wide rounded umbilical area, flush sutures, and wide pore perforated wall.

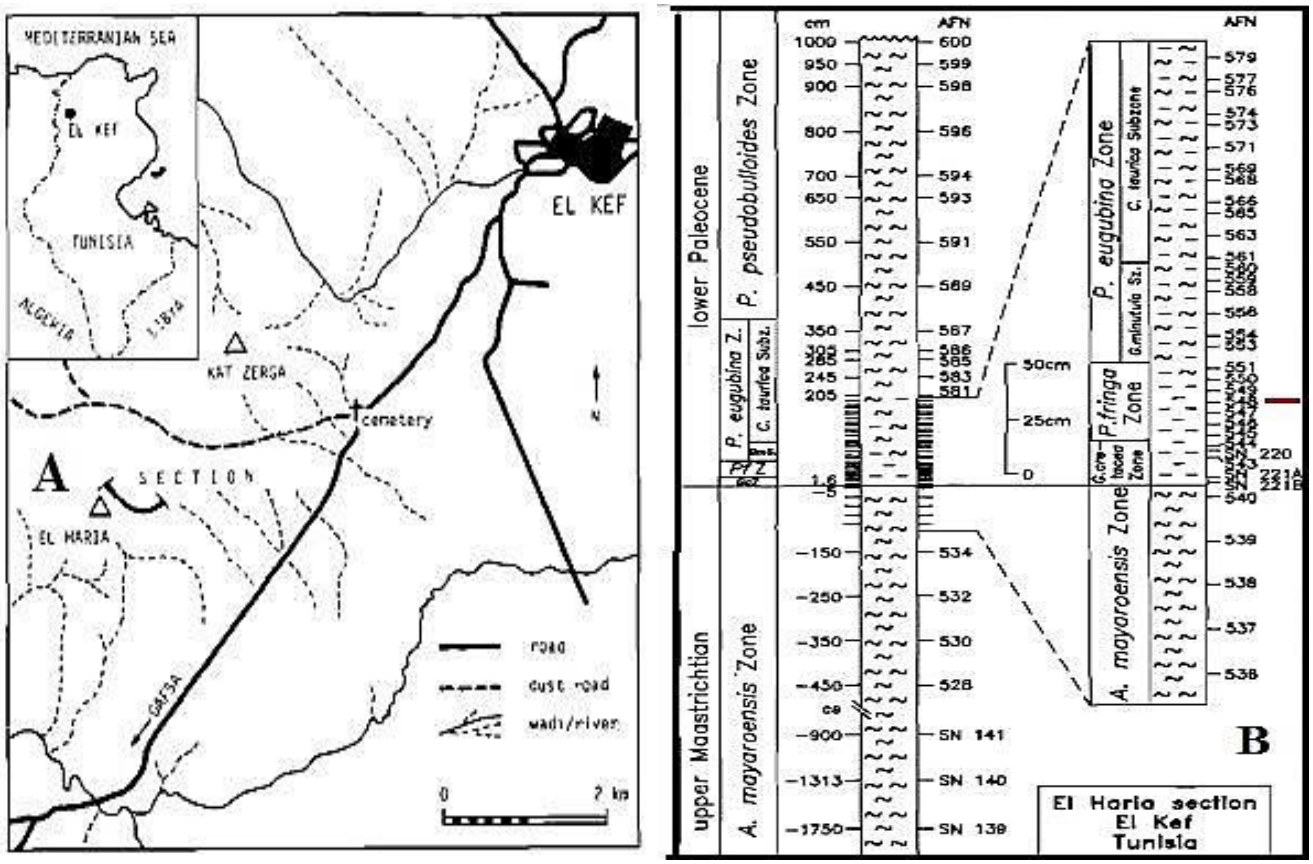

Figure 3: (A) The location map of Tunisia, west North Africa, (B) the stratigraphic level of the *Gyroidinoides tunisica* n. sp.

Gyroidinoides zelandica (=*Gyroidina zelandica* Finlay, 1939 p. 323, pl. 28, figs. 138- 140, sensu Jannou, 2009, p. 116, Figure 13U) (Finlay, 1939).

Remarks: It is characterized by open wide umbilicus with long broad slit at base of the last chamber.

4. PALEOGEOGRAPHY

The eleven recorded species belong to the diagnostic calcareous Rotaliid benthic foraminiferal genus *Gyroidinoides* have wide stratigraphic distribution from many parts of the Southern Tethys: Argentina, Gulf of Guinea, Tanzania, Tunisia, Egypt, Jordan, UAE, Pakistan, and New Zealand (see Figure 1). According to many authors the Southern Tethys had been connected from west Atlantic Ocean to the west, to the Indo-Pacific Ocean to the east, via the Mediterranean Sea during the Upper Cretaceous-Paleogene time (Abed, 2013).

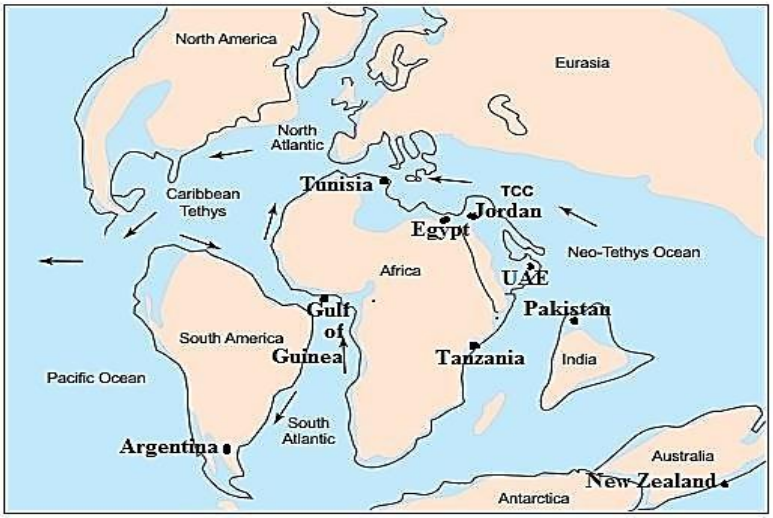

Figure 4: Paleogeography of the Neo-Tethys Ocean during the Maastrichtian showing the flow direction of the Tethyan Circumglobal Current (TCC) from east to west, and the locations of the different countries that recorded in this study (after Abed, 2013, with some modifications).

Some remarks of the paleogeographic distribution of the recorded species can be added:

Five species of the assemblage were recorded from Egypt (about 45%): *Gyroidinoides aegyptiaca*, *G. brotzeni*, *G. frizzelli*, *G. luterbacheri*, *G. reussi* (Anan, 2004; Ansary, 1955; Said and Kenawy, 1956).

Two species from Pakistan (about 18%): *G. sarwari* and *G. tayyabi* (Haque, 1956; Haque, 1960).

One species (about 10%) from each of Tunisia (*G. tunisica*, n. sp.), Côte d'Ivoire-Ghana Transform Margin and Tanzania (*G. africana*, n. sp.), Jordan (*G. tellburmaensis* Futyan, New Zealand *G. zelandica* (Finlay, 1939; Futyan,

1976).

Gyroidinoides africana Anan, n. sp. are recorded from Gulf of Guinea (west Africa) and Tanzania (east Africa).

Gyroidinoides reussi are recorded from Egypt (northeast Africa) and UAE (southwest Asia) (Said and Kenawy, 1956).

Gyroidinoides tellburmaensis Futyan are recorded from Jordan (southwest Asia) and Tunisia (northwest Africa) (Futyan, 1976).

Gyroidinoides zelandica are recorded from New Zealand (southeast Australia, Pacific Ocean) and Argentina (South America, Atlantic Ocean) (Finlay, 1939).

5. Paleoenvironment

Most recorded species in this study were erected from many countries in the Southern Tethys (Argentina, Gulf of Guinea, Tanzania, Tunisia, Egypt, Jordan, UAE, Pakistan and New Zealand), which are indicated open connection of the Tethys and represent outer neritic-upper bathyal environment (Figure 5).

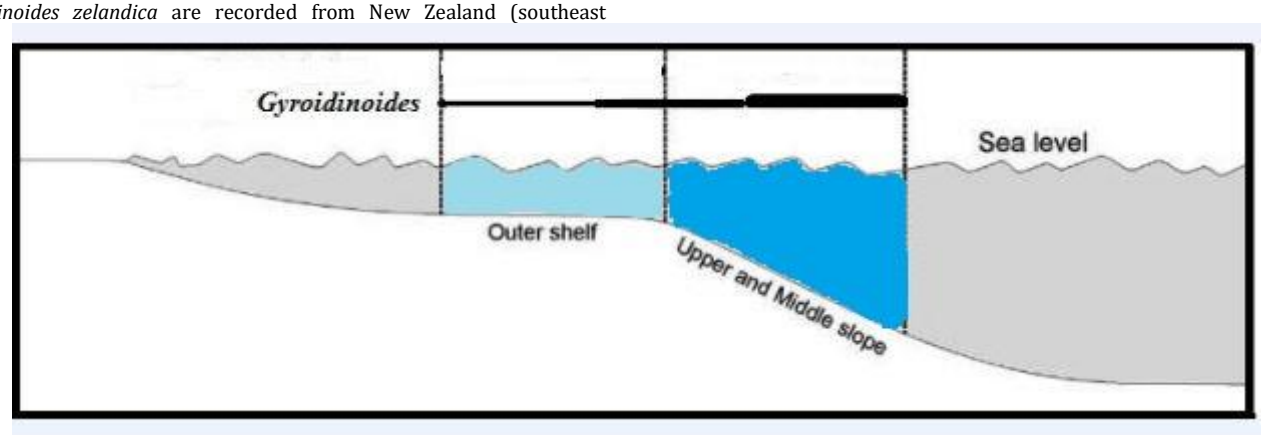

Figure 5: Wide range of the members of the genus *Gyroidinoides*, from outer shelf-upper-middle slop environment (after Jaff and Lawa, 2019).

6. Conclusions

The present study deals with the recording of eleven members of the calcareous Rotaliid foraminifera genus *Gyroidinoides* were originally erected from some localities in the Southern Tethys (Gulf of Guinea, Tanzania, Tunisia, Egypt, Jordan, Pakistan and New Zealand). Some of the identified species are also recorded far than its original erection in other localities in the South America (Argentina), and Southern Tethys (UAE). 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 Upper Cretaceous-Paleogene time. Environmental conditions of the identified species represent outer shelf-upper-middle slop environment.

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