

Contribution to the paleontology of the Campanian-Neogene benthic foraminiferal Textulariid and Lagenid genera and species

Abstract

Vaginulinoides and *Vaginulinella* two new genera, both of Anan (this study) are introduced here to include the two benthic Lagenid Foraminiferids from Chile, in the Southern Tethys, that characterized by its planispirally enrolled and involute early stage, and later uncoiled of the test, with ornamented surface. The first one *Vaginulinoides* has the same characters of the *Vaginulinopsis* with curved test, but differs in its longitudinal ribs along the surface test. This genus is represented by *Marginulina cubana* Palmer, in Finger¹ (2013, Plate 10, Figure. 10, non Figure. 9) which related here to the new genus *Vaginulinoides*. The second new genus *Vaginulinella* also has the same characters of the genus *Vaginulinoides* but with erect rectilinear test, which represented here by *Dentalina obliquecostata* (Stache) in Finger¹ (Plate 6, Figure. 21) and treated here to belong to the new genus *Vaginulinella*. On the other hand, another three new members of the diagnostic calcareous benthic agglutinated foraminiferal genus *Pseudogaudryinella* Cushman were erected from many localities in the world: *Pseudogaudryinella baliniaki* (North Europe, Poland), South Europe, *P. ortizae* (Spain), and *Pseudogaudryinella iraqensis* (Middle East, Iraq), beside the type locality of this genus *P. capitosa*, which was erected earlier from USA by Cushman. These Tethyan taxa, most probably indicate an open marine environment of Chile (South America), USA (North America), Europe and Southwest Asia, which represents middle-outer neritic environment (100 m ~ 200 m depth), and shows an affinity with Midway-Type Fauna (MTF) of the United States Gulf Coastal area.

Keywords: paleontology, foraminifera, campanian, neogene, textulariid, lagenid

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Introduction

This work includes two parts of studies, which presenting two new genera of Lagenid benthic foraminifera in one hand: *Vaginulinoides* and *Vaginulinella*, and also proposed three new species of Textulariid benthic foraminiferal genus *Pseudogaudryinella* (*P. baliniaki*, *P. ortizae* and *P. iraqensis*), in the other hand.

The present author believes that the three specimens in Loeblich & Tappan² (plate 412, Plate 450, Figures 2, 4, 5) represents the genus *Vaginulinopsis* Silvestri³ which has “an elongate test, early stage planispirally enrolled and involute, later uncoiled and rectilinear, laterally compressed and ovate to lenticular in section, sutures radial in the early stage, straight, horizontal, and may be slightly depressed in the uncoiled stage wall calcareous, perforate, optically radial, surface smooth and unornamented; aperture terminal, radiate, at the dorsal angle” are applies only for one Figure specimen (Figure 2, Plate 450 of Loeblich & Tappan)² while the other two forms (Figure. 4, 5) have ornamented tests, which differs from the smooth genus *Vaginulinopsis* (Plate 1).

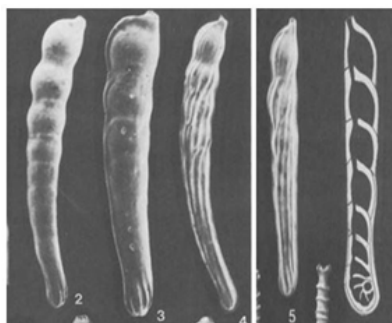


Plate 1 The different forms (2-6) of the genus *Vaginulinopsis* (after Loeblich & Tappan).²

Material of Study

The Figure specimen no. 3, Plate 450 (in Loeblich & Tappan)² can be treated here as a separate new genus: *Vaginulinoides*, which has the same characters of *Vaginulinopsis*, except in its ornamented surface (with longitudinal ribs along the whole test). This treatment was used to separate between *Pyramidulina* Fornasini⁴ and *Nodosaria* Lamarck⁵ (Test elongate, arcuate, uniserial, proloculus apiculate, chambers cylindrical to ovate, enlarging gradually as added, sutures horizontal; wall calcareous, hyaline radial in structure, with secondary lamination, surface with numerous longitudinal costae; aperture terminal, radiate).

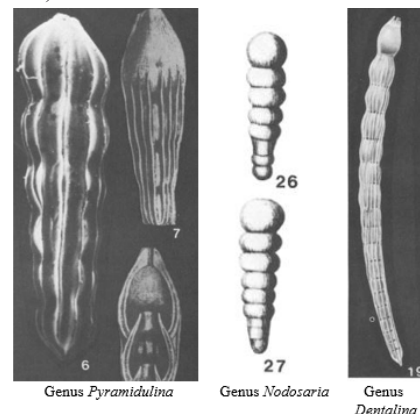


Plate 2 after Loeblich & Tappan²: *Pyramidulina*, *Nodosaria* and *Dentalina*.

Moreover, the rectilinear Figure specimen no. 5, Plate 450 (in Loeblich & Tappan)² is treated here as another new genus: *Vaginulinella*, with ornamented surface (as *Vaginulinoides*), but with erected non-curved test. It is look-like what were happen for

the separation of the two ornamented genera *Dentalina* (curved test with longitudinal ribs along the surface of the test (Figure 19, Plate 439, in Loeblich & Tappan)² and *Pyramidulina* (rectilinear test with longitudinal ribs along the surface of the test (Figure 6, Plate 441, in Loeblich & Tappan)²

The different species of the genus *Vaginulinopsis* in the Northern and Southern Tethys are presented in Plate 3. The *Vaginulinopsis* members are distinguished by elongate smooth tests, large coiled portion, flush sutures in the early part of the uncoiled portion, but depressed in the upper part.

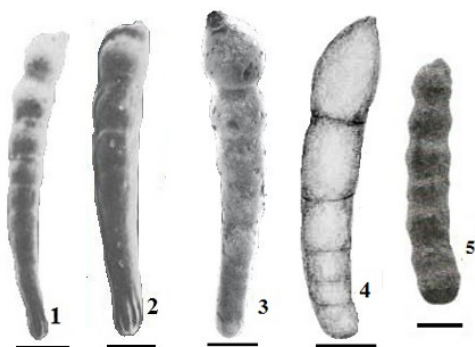


Plate 3 Figures 1, 2. *Vaginulinopsis carinata* (Silvestri)³ from Italy, 3. *Vaginulinopsis argentinica* Anan⁶ (= *Laevidentalina* sp. Jannou et al.⁷ plate. 21, plate 2, Figure 5) from Argentina, 4. *Vaginulinopsis deserti* (Said & Kenawy)⁸ (= *Marginulinopsis deserti* Said & Kenawy⁸, plate. 132, plate 2, Figure)²³ from Egypt, 5. *Vaginulinopsis emiratensis* (Anan⁹ 1993) (= *Marginulinopsis emiratensis* Anan⁹ plate. 657, plate. 2, Figure. 12) from UAE.

Systematic paleontology

A. Part I

The taxonomy of the identified genera and its species follows that of Loeblich & Tappan² and the illustrated taxa have been shown in Plate 4, Figures a, b.

Order Foraminiferida Eichwald, 1830

Suborder Lagenina Delage & Hérouard, 1896

Superfamily Nodosariacea Ehrenberg, 1838

Family Nodosariidae Ehrenberg, 1838

Subfamily Marginulininae Wedekind, 1937

Genus *Vaginulinoides* Anan, n. gen.

Type species *Vaginulinoides fingeri* Anan, n. sp.

Vaginulinoides fingeri Anan, n. sp. (Plate 4, Figures 4a, b)

1988 *Vaginulinopsis carinata* (Silvestri). Loeblich & Tappan,⁹plate. 412, Plate 450, Figure 4.

2013 *Marginulina cubana* Palmer. Finger,¹ p. 416, Plate 10, Figure 10.

Holotype: Illustrated specimen of the holotype in Figure 4a.

Paratype: Illustrated specimen of the holotype in Figure 4b.

Age and locality of the holotype: Late Oligocene, Cuba.

Stratigraphic range: Late Oligocene to Early Miocene.

Etymology: In the honor of Kenneth L. Finger, University of California, Berkeley, USA.

Depository: University of California Museum of Paleontology (UCMP50190).

Occurrence: Navidad Fm. (MOS, PPP, PTA), Ranquil Fm. (MS10) of Chile (Figure 1).

Maximum relative abundance: Common (MS10) (Table 1).

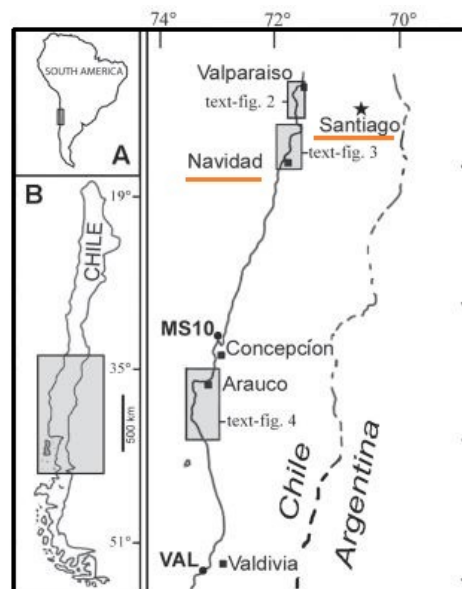


Figure 1 The location map of the different formations in Chile: Navidad and Arauco Formations (after Finger).¹

Table 1 The abundancy of the *Vaginulinoides fingeri* in different formations, Chile (after Finger)¹

| SECTOR | North | | Central | | | | | | | | | | | | | | | | | | | | |
|---------------|---------------|-------------|---------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|-----|-----|-----|-----|-----|-----|-----|--|
| | Las Cruces | Navidad | | | | | | | | | | | | | | | | | | | | | |
| AREA | Las Cruces | Navidad | | | | | | | | | | | | | | | | | | | | | |
| GEOLOGIC UNIT | El Peral beds | Navidad Fm. | | | | | | | | | | | | | | | | | | | | | |
| LOCALITY | NLP | LPER | VR | MOS | RAP | PPP | PPT | PPN | LBZ | PTA | MAT | NAV5 | MPUP | CPUP | MS10 | FRA | FRM | RQT | RQK | RAN | MIB | LEB | |
| | | | | | | F | | | | F | | | | | C | | | | | | | | |

Diagnosis: Elongate test; early stage planispirally enrolled and involute, later uncoiled and curved; laterally ovate to lenticular in section; sutures radial in the early stage, but straight, horizontal and

depressed in the uncoiled uniserial stage; wall calcareous, perforate, optically radial; surface ornamented by longitudinal ribs along the chambers; aperture terminal, radiate, at the dorsal angle.

Remarks: The *Vaginulinoides fingeri* Anan (new genus and new species) resemble the genus *Vaginulinopsis* Silvestri³ in main characters of the test, except the ornamented longitudinal ribs on the test surface of the former, than the smooth test in the latter. The ornamented ribs are covered the chambers in the holotype specimen (Figure 4a), while it exists in the chambers and extended along the test crossing the sutures in the paratype specimen (Figure 4b).



Plate 4a, 4b The illustrated specimens of the *Vaginulinoides fingeri* Anan, a. Holotype, b. Paratype.

Genus *Vaginulinella* Anan, n. genus

Type species *Vaginulinella fingeri* Anan, n. plate.

Vaginulinella fingeri Anan, n. p. (Plate 5, Figure 5a-c)

1988 *Vaginulinopsis carinata* (Silvestri). Loeblich & Tappan,² p. 412, Plate 450, Figures 5,6.

2013 *Dentalina obliquecostata* (Stache). Finger,¹ p. 400, Plate 6, Figure 21.

Holotype: Illustrated specimen of the holotype in Figure 5a.

Paratype: Illustrated specimen of the paratypes in Figure 5b,c.

Age and locality of the holotype: Late Tertiary, New Zealand.

Stratigraphic range: Miocene.

Etymology: In the honor of Kenneth L. Finger, University of California, Berkeley, USA.

Depository: University of California Museum of Paleontology (UCMP50106).

Occurrence: Navidad Fm. (PPN, PPP, RAP), Ranquil Fm. (RAN). (Figure 1)

Maximum relative abundance: Common (RAP). (Table 2)

Table 2 The abundancy of *Vaginulinella fingeri* in different formations of Chile (after Finger)¹

| SECTOR | North | | Central | | | | | | | | | | | | | | | | Vald | | |
|---------------|---------------|-------------|-------------|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|-----|-----|-----|-----|--------|-----|-----|
| AREA | Las Cruces | Navidad | Conc | | | | | | | | | | | | | | | | Arauco | | |
| GEOLOGIC UNIT | El Peral beds | Navidad Fm. | Ranquil Fm. | | | | | | | | | | | | | | | | SDom | | |
| LOCALITY | NLP | LPER | MOS | RAP | PPP | PPT | PPN | LBZ | PTA | MAT | NAV5 | MUPP | CPUP | MS10 | FRA | FRM | RQT | RQK | RAN | MIB | LEB |
| | | | | C | VR | | R | | | | | | | | | | | | | R | |

Diagnosis: Elongate test; early stage planispirally enrolled and involute, later uncoiled and rectilinear; laterally ovate to lenticular in section; sutures radial in the early stage, but straight, horizontal to slightly depressed in the uncoiled uniserial stage; wall calcareous, perforate, optically radial; surface ornamented by longitudinal ribs along the chambers and whole test; aperture terminal, radiate, at the dorsal angle.

Remarks: The *Vaginulinella fingeri* Anan (new genus and new species) resemble the genus *Vaginulinoides* Anan (n. gen.) in main characters of the test, except the rectilinear test than curved, ornamented longitudinal ribs along the test surface. The ornamented ribs are covered the chambers and crossing the sutures, inclined in the holotype specimen (Figure 5a), while vertical and extended along the test crossing the sutures in the paratype specimen (Figure 5b). The Figured specimen (Figure 5c) explained the longitudinal section of the test (after Loeblich & Tappan)².

The paleogeographic distribution of these taxa are distributed in many localities in the Tethys (Caribbean Sea and New Zealand), as well as some other Tethyan countries: Chile, Argentina, UAS, Spain, Poland, Egypt, Iraq, UAE and Iran (Figure 2).

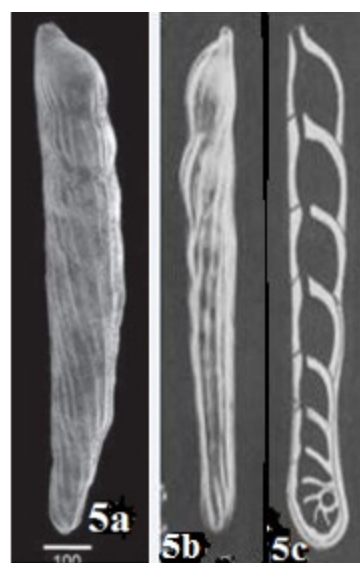


Plate 5a, 5b, 5c



Figure 2 Location map of the new genera and species in different localities in the world: North America (USA) and South America (Chile, Argentina), Europe (Spain, Poland), Middle East (Egypt, Iraq, UAE, Iran), and South Pacific (New Zealand).

Moreover, the rectilinear Figure specimen no. 5, Plate 450 (in Loeblich & Tappan)² is treated here as another new genus: *Vaginulinella*, with ornamented surface (as *Vaginulinoides*), but with erected non-curved test. It is look-like what were happen for the separation of the two ornamented genera *Dentalina* (curved test with longitudinal ribs along the surface of the test (Figure 19, Plate 439, in Loeblich & Tappan)² and *Pyramidulina* (rectilinear test with longitudinal ribs along the surface of the test (Figure 6, Plate 441, in Loeblich & Tappan).²

A. Part II

- Order Foraminiferida Eichwald, 1830
- Suborder Textulariina Delage and Hérouard, 1896
- Superfamily Verneulinacea Cushman, 1911
- Family Verneulinidae Cushman, 1911
- Subfamily Verneulininae Cushman, 1911
- Genus *Pseudogaudryinella* Cushman, 1936

***Pseudogaudryinella capitosa* (Cushman, 1933) (Plate 6, Figure 1)**

1933 *Gaudryinella capitosa* Cushman,¹² p. 52, Plate 5, Figure 8.

1946 *Pseudogaudryinella capitosa* (Cushman). (Cushman),¹⁴ p. 171, Plate 10, Figure. 15; Martin¹⁵ p. 54, Plate 3, Figure. 7; Loeblich & Tappan² p. 137, Plate 144, Figures. 11, 12.

Remarks: Test elongate, triserial in the early stage and triangular in section, then biserial, and finally uniserial and rounded in section, wall agglutinated simple, aperture terminal and rounded.

Occurrence: It was recorded, so far, from USA.

***Pseudogaudryinella baliniaki* Anan, n. sp. (Plate 6, Figure 2)**

2018 *Pseudogaudryinella* sp. 1, Baliniak.¹⁶ p. 382, Plate 1, Figure 13.

Holotype: Illustrated specimen in plate 1, Figure 2

Diameter of the holotype: Length 1.40 mm, width 0.54 mm.

Etymology: After Weronika Baliniak, Faculty of Geography and Geology, Jagiellonian University, Kraków, Poland.

Depository and type locality: Sample 1, J55, slope marl assemblages of the Fore-Magura Thrust Sheet, Polish Outer Carpathian (Figure 3)

Age: Paleocene-Eocene.

Type species *Gaudryinella capitosa* Cushman, 1933

Remarks on the genus: Beside the type species of the genus *Pseudogaudryinella capitosa* (Cushman) from USA, and *P. iranica* (Anan) another three species of them are believed here as new: *Pseudogaudryinella baliniaki* (from Poland), *P. ortizae* (from Spain), and *P. iraqensis* (from Iraq). The stratigraphic position of them are also presented. The modern references have been added to complete the descriptions of the recorded species, which are illustrated in (Plate 6).

Test elongate, early stage triserial triangular in section, followed by biserial, and finally uniserial rounded in section, aperture rounded terminal on short neck in the last chamber. The genus *Pseudogaudryinella* differs from *Tritaxia* Reuss¹¹ in having a biserial stage intercalated between the triserial and uniserial ones, and differs from *Gaudryina* d’Orbigny¹¹ in becoming uniserial in the adult.



Plate 6

(All scale bars 100µm)

1. *Pseudogaudryinella capitosa* (Cushman)¹² type species, side view.
2. *P. baliniaki* Anan, n. sp., side view.
3. *P. iranica* Anan,¹³ side view.
4. *P. iraqensis* Anan, n. sp., side view.
5. *P. ortizae* Anan, n. sp., side view.

Description: Test elongate, triserial in the early stage and triangular in section, later becoming biserial and finally lax uniserial, wall finely agglutinated with calcareous cement, ended by rounded terminal aperture.

Remarks: The early triserial stage occupies one-third up to half of the test and triangular in section, but rounded section in the later biserial and uniserial stages. *P. baliniaki* Anan differs from *P. ortizae* Anan by its finely agglutinates wall than coarser grain-size wall, also by its smaller test-size, rounded section of the uniserial stage than discoidal shape, and depressed aperture on the last chamber of the former than terminal on neck of the latter.

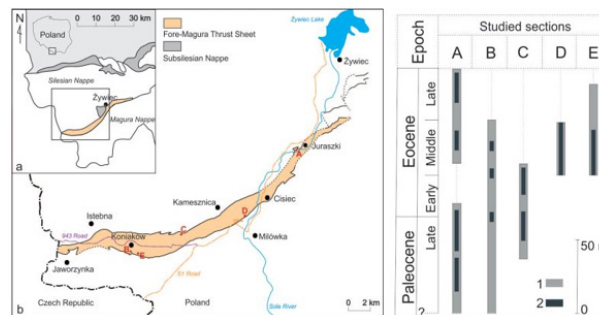


Figure 3 Location of studied sections (including Juraszki, A section) in the western part of the Polish Outer Carpathians (after Baliniak).¹⁶

***Pseudogaudryinella iranica* Anan, 2022** (Plate 6, Figure 3)

2021 *Gaudryina* sp. Salahi,¹⁷ p. 314, Plate 4, Figure. 23 (*non* Figure 28).

2022 *Pseudogaudryinella iranica* Anan,¹³ p. 16, Plate 1, Figure 5.

Remarks: This species differs from *Pseudogaudryinella iraqensis* Anan n. sp., by its longer and irregular triserial portion, lesser size of the uniserial final chamber, and younger stratigraphic position (Ypresian than Campanian).

***Pseudogaudryinella iraqensis* Anan, n. sp.** (Plate 6, Figure 4)

2019 *Tritaxia whitei* (Cushman and Jarvis). Jaff & Lawa,¹⁸ p. 14, Plate 2, Figures 14,15.

Holotype: Illustrated specimen in Plate 1, Figure 4.

Dimension: Length 0.45 mm, width 0.17 mm.

Etymology: After the Iraq Republic.

Depository and type locality: Department of Geology, University of Sulaimani, Shiranish Formation, Kurdistan region, Northeast Iraq (Figure 4).

Age: Campanian (MPK14669, Azmer section, sample number ASH-25).

Description: *Pseudogaudryinella iraqensis* has moderately elongate test, early stage triserial triangular in section, followed by biserial, and finally uniserial rounded in section, aperture terminal rounded in the last chamber.

Remarks: This species has smaller test than *Pseudogaudryinella baliniaki* n. sp. and *P. iranica* Anan.¹³ The three parts of the arrangement occupied one third of the test, and aperture on the last semi-globular chamber terminal on neck.

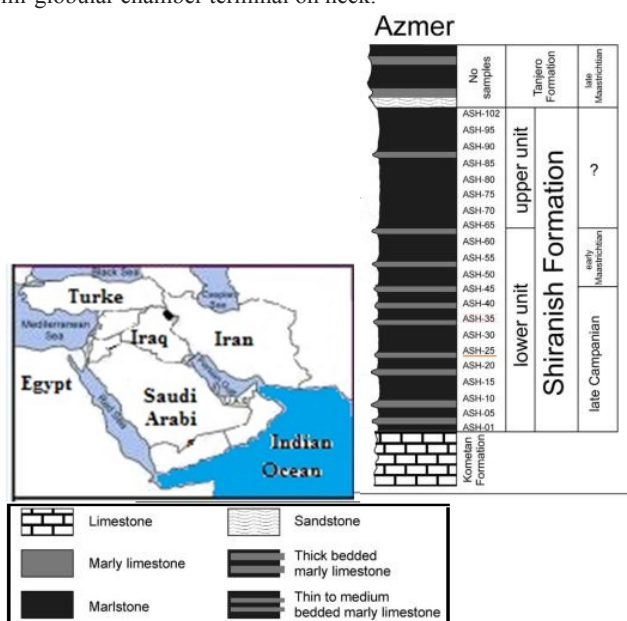


Figure 4 Location map of Azmer section, Northeast Iraq, the stratigraphy of Azmer section, and the position of the sample no. ASH-25 of the new species *Pseudogaudryinella iraqensis* Anan, n. sp. (after Jaff & Lawa).¹⁸

***Pseudogaudryinella ortizae* Anan, n. sp.** (Plate 6, Figure 5)

2006 *Clavulinoides angularis* (d'Orbigny). Ortiz & Thomas,¹⁹ p. 102, Plate 1, Figure. 3 (*non* Figures. 1, 2, 4, 5).

Holotype: Illustrated specimen in Plate 1, Figure 5.

Diameter of the holotype: Length 2.50 mm, width in the middle portion 1.00 mm.

Etymology: After Silvia Ortiz, University of Zaragoza, Spain (Figure 5).

Depository and type locality: Sample 4, Fortuna Section, Betic Cordillera, southeastern Spain (after Ortiz & Thomas).¹⁹

Age: Ypresian.

Description: Test large, elongate and tricarinate in its triserial and triangular in section, biserial and finally discoidal uniserial stage, aperture terminal rounded, more coarser grain-size wall, ended by rounded terminal aperture.

Remarks: This species has larger test size than *P. iranica* Anan,¹³ and does not have globular last chamber, and more coarser grain-size wall.

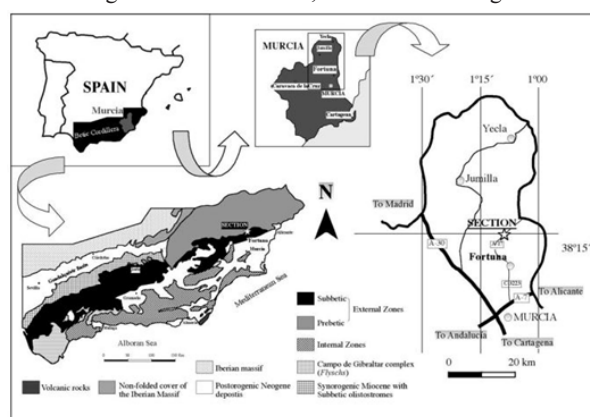


Figure 5 Location map of Fortuna section, south Spain (after Ortiz & Thomas).¹⁹

Paleobiogeography

The two new Lagenid genera *Vaginulinoides* and *Vaginulinella*, and also three new species of Textulariid benthic foraminiferal genus *Pseudogaudryinella* (*P. baliniaki*, *P. ortizae* and *P. iraqensis*), have wide geographic distribution: North Atlantic (USA, Caribbean), South Atlantic (Chile, Argentina), Europe (Spain, Poland), Northeast Africa (Egypt), Southwest Asia (UAE, Iraq, Iran), and Southwest Pacific (New Zealand) (Figure 2). Berggren²⁰ suggested that during the Paleogene, the fauna of the Mediterranean and the Indo-Pacific exhibit pronounced similarities, which indicate that the connection between the two areas mentioned by a marine seaway, and the East Atlantic fauna was much more closely related to the fauna than it is today. In western Atlantic a narrow connection between it and Pacific existed. Miller et al.²¹ Infer that certain hydrographic properties (low oxygen, high CO₃, low pH, and thus more corrosive waters) favor the development of agglutinated assemblages. Due to the high abundance of pelagic Tethyan foraminiferal assemblage indicate open connections from Atlantic Ocean to the Indian Ocean and represents middle-outer neritic environment (100-200m depth) and shows an affinity with “Midway-Type Fauna” by many authors,^{17,21-24} 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 and 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. Mediterranean and the Indo-Pacific exhibit pronounced similarities, which indicate

that the connection between the two areas mentioned by a marine seaway, and the East Atlantic fauna was much more closely related to the fauna than it is today. In western Atlantic a narrow connection between it and Pacific existed. The paleogeographic maps recorded by many authors²⁶⁻²⁹ show the Tethyan realm had been connected with the Atlantic Ocean from west to the Indo-Pacific Ocean to the east, via the Mediterranean Sea, crossing the Middle East region during the Late Cretaceous-Paleogene times, and the fauna exhibit pronounced similarities. (Figure 6)



Figure 6 Paleogeography of the Neo-Tethys ocean during the late Cretaceous-Paleogene times showing the flow direction of the Tethyan Circumglobal Current (TCC) from east to west, and from north to south (after Abed).²⁹

Conclusion

Two new of Lagenid benthic foraminifera genera: *Vaginulinoides* and *Vaginulinella* from Cuba and New Zealand, and also three new species of Textulariid benthic foraminiferal genus *Pseudogaudryinella* (*P. baliniaki*, *P. ortizae* and *P. iraqensis*) from Poland, Spain and Iraq are presented in this study. These Tethyan taxa, most probably indicate an open marine environment of Chile (South America), USA (North America), Europe and Southwest Asia, which represents middle-outer neritic environment (100m~200m depth), and shows an affinity with Midway-Type Fauna (MTF) of the United States Gulf Coastal area. The deeper water agglutinated species have smooth tests, while the shallow water specimens have coarser grained.

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Conflicts of interest

Authors declare that there is no conflict of interest.

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