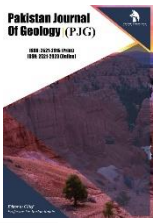
ZIBELINE INTERNATIONAL™ PUBLISHING

Pakistan Journal of Geology (PJG)

DOI: http://doi.org/10.26480/pjg.02.2024.141.148

ISSN: 2521-2915 (Print)
ISSN: 2521-2923 (Online)
CODEN: PJGABN



RESEARCH ARTICLE

TAXONOMIC CONSIDERATION OF THE PALEOGENE BENTHIC FORAMINIFERAL SPECIES OF IVORIAN BASIN AND ITS PALEOGEOGRAPHIC DISTRIBUTION IN THE TETHYS

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ARTICLE DETAILS

Article History:

Received 23 June 2024
Revised 09 July 2024
Accepted 23 August 2024
Available online 26 August 2024

ABSTRACT

The present study deals with the modern taxonomical consideration of the thirty six smaller benthic foraminiferal Paleogene species belonging to twenty six genera from Holes 960a and 960c, of the Ivorian Basin, west Africa, central Atlantic Ocean were identified by Bignot (1988), which represent good example of the Tethyan assemblage. The Southern Tethyan assemblage of Ivorian Basin indicates an open marine environment, which represents outer neritic-abyssal environment. The wide paleogeographic distribution of this assemblage in different localities in the Northern and Southern Tethys: USA, Mexico, Caribbean, Peru, Venezuela, Brazil, Spain, France, Germany, Sweden, Austria, Hungaria, Italy, Ivorian Basin, Angola, Libya, Egypt, United Arab Emirates (UAE), Pakistan, New Zealand. indicate that the ancestral Tethys is connected with the ancestral Atlantic, Indian Oceans (via Mediterranean Sea) and Pacific Ocean. Environmental conditions of the identified species represent outer shelf- Bathyal environment (~200-2000m).

KEYWORDS

Foraminifera, Paleogene, North America, South America, Atlantic, Africa, Middle East, New Zealand, Tethys

1. INTRODUCTION

The present study deals with the taxonomic consideration of Paleogene thirty six benthic foraminiferal species of three suborders (4 Textulariid species, 8 Lagenid species and 24 Rotaliid species) from the Holes 960a and 960c, of Ivorian Basin, west Africa, central Atlantic Ocean (Figure 1).

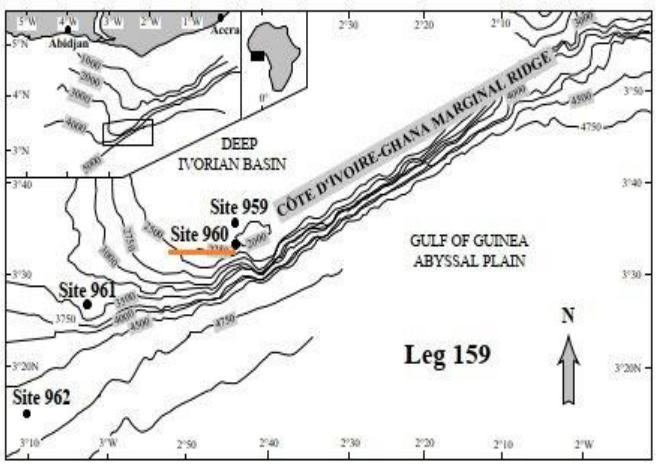

Figure 1: Location map of the Holes 960a and 960c of Ivorian Basin, Central Atlantic Ocean (after Bignot, 1988).

These recorded species are correlated with the synchronous foraminiferal species from other Tethyan localities, e.g.: Northern Tethys (USA, Mexico, Caribbean, Spain, France, Hungaria, Germany, Sweden, Italy) and Southern Tethys (Venezuela, Peru, Brazil, Libya, Egypt, Ivorian Basin, Angola, UAE Pakistan, New Zealand) which are shown in Figure 2.

Figure 2: Geographic distribution of the recorded taxa from most localities in the Tethys: North and South America, Caribbean, Europe, Africa, Asia, New Zealand.

2. MATERIAL AND METHODS

The modern taxonomical consideration of thirty six smaller benthic foraminiferal species belonging to twenty six genera of the faunal assemblage were recorded from the Eocene Ivorian sedimentary basin, central Atlantic Ocean is treated in this study The stratigraphic range of twelve species of them is shown in (Figure 3).

Quick Response Code	Access this article online	
	Website: www.pakjgeology.com	**DOI:** 10.26480/pjg.02.2024.141.148

Cite The Article: Haidar Salim Anan (2024). Taxonomic Consideration of The Paleogene Benthic Foraminiferal Species of Ivorian Basin and Its Paleogeographic Distribution in The Tethys. *Pakistan Journal of Geology, 8(2): 141-148.*

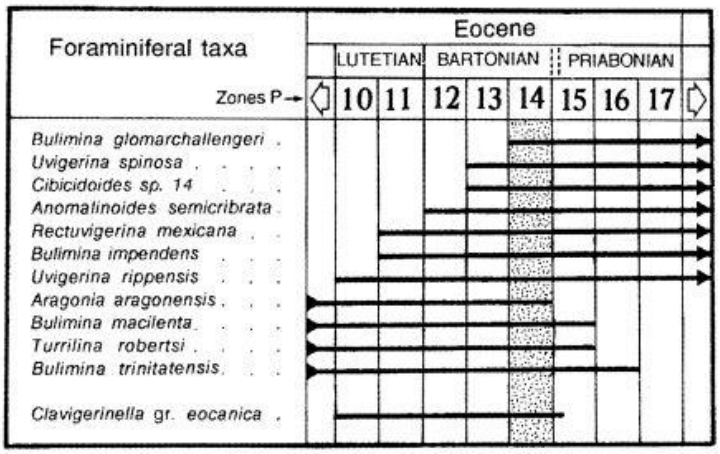

Figure 3: Stratigraphic range and correlation of some selected stratigraphic index foraminiferal species. The joint occurrence of these species characterizes the P14 zone, stippled area (after Bignot, 1988).

3. SYSTEMATIC PALEONTOLOGY

The taxonomy of Loeblich & Tappan (1988) is followed here for thirty six benthic foraminiferal species were recorded from the Eocene stratigraphic succession of Holes 960a and 960c, from Ivorian Basin. These identified species are illustrated in Plate (1).

Plate 1: (Scale bars =100µm) 1.Tritaxia havanensis (Cushman & Bermudez, 1937), 2. Vulvulina haeringensis (Gümbel, 1868) 3. Eggerella palmerae (Cole, 1927), 4. Karreriella siphonella Reuss (1851), 5. Vaginulinoides africana Anan, n. sp., 6. Chrysalogonium asperum Cushman & Stainforth (1945), 7. Chrysalogonium laeve Cushman & Bermúdez (1936), 8. Chrysalogonium vicksburgensis Todd (1952), 9. Amphimorphina haueriana Neugeboren (1850), 10. Awhea africana Anan, n. sp., 11. Nodosaria radicula (Linne, 1758), 12. Cushmanina striatopunctata (Parker & Jones, 1865), 13. Bulimina glomarchallengeri Tjalsma & Lohmann (1983), 14. Bulimina impendens Parker & Bermudez (1937), 15. Bulimina macilenta Cushman & Parker (1939), 16. Bulimina semicostata Nuttall (1930), 17. Bulimina trinitatensis Cushman & Jarvis (1928), 18. Uvigerina rippensis Cole (1927), 19. Uvigerina spinosa Boersma (1984), 20a, b. Pseudobuliminella africana Anan, n. sp., 21. Pyramidina africana Bignot (1988), 22. Turrilina robertsi (Howe & Ellis, in Howe 1939). 23. Nonion florinensis (Cole, 1927), 24. Nonion havanense Cushman & Bermúdez (1937), 25. Pullenia eocenica Cushman & Siegfus (1939), 26. Anomalinoides semicribrata (Beckmann, 1954), 27. Nuttallides truempyi Nuttall (1930), 28. Cibicidoides grimsdalei (Nuttall, 1930), 29. Osangularia pteromphali (Gümbel, 1868), 30. Nodosarella africana Anan, n. sp., 31. Aragonia aragonensis Nuttall (1930), 32. Pleurostomella brevis Schwager (1866), 33. Pleurostomella naranjoensis Cushman & Bermudez (1936), 34. Pleurostomella nuttalli Cushman & Siegfus (1939), 35. Caucasina africana Anan, n. sp., 36. Globocassidulina subglobosa (Brady, 1881).

Order Foraminiferida Eichwald, 1830

Suborder Textulariina Delage & Hérouard, 1896

Tritaxia havanensis (Cushman & Bermudez, 1937)(=*Clavulinoides havanensis*, pl. 13, figs. 4). Eocene. Cuba, Angola Basin, South Atlantic Ocean, central Atlantic Ocean Ivorian Basin (IB).

Vulvulina haeringensis (Gümbel, 1868) (=*Venilina haeringensis*, p. 71, pl. 2, figs. 84). Eocene-Oligocene. Germany, Mexico, Peru, Ivorian Basin.

Eggerella palmerae (Cole, 1927)(=*Verneuilina palmerae*, p. 12, pl. 2, fig. 30). Mexico, Ivorian Basin.

Karreriella siphonella Reuss, 1851, p. 78, pl. 5, figs. 40–42. Oligocene. Germany, Ivorian Basin.

Suborder Lagenina Delage & Hérouard, 1896

Genus Vaginulinoides Anan, 2023

Type species *Vaginulinoides fingeri* Anan, 2023

Vaginulinoides africana Anan, n. sp. (=*Vaginulinopsis fragaria* of Bignot, 1988, p. 57, pl. 1, fig. 58).

Holotype: Plate 1, Figure 5.

Etymology: after Ivorian Basin, west Africa, central Atlantic Ocean, Holes 960A and 960C, Ocean Drilling Program (ODP), Leg 159 (Fig. 1).

Stratigraphic level: Middle Eocene (Figure 4).

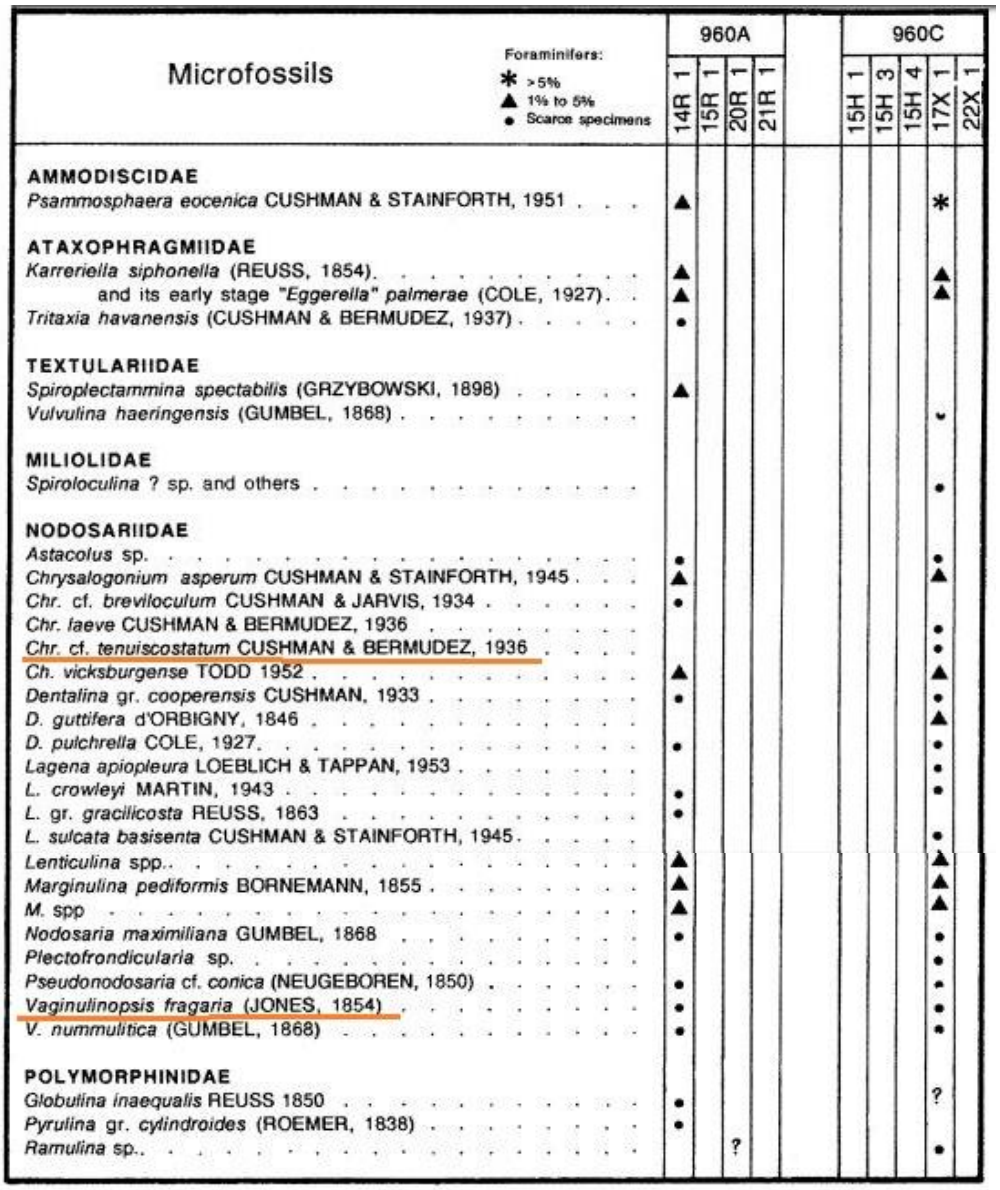

Figure 4: Distribution of microfossils in analyzed samples from Holes 960A and 960C (ODP), including the *Awhea africana* Anan, n. sp. (=*Chrysalogonium* cf. *tenuiscostatum*), and *Vaginulinoides africana* Anan, n. sp. (=*Vaginulinopsis fragaria*) both of Bignot, 1988).

Diagnosis: *Vaginulinoides africana* Anan n. sp. has elongate compressed test, early stage planispirally enrolled and involute, later uncoiled and slightly curved, ornamented mainly by a longitudinal ribs on the test surface extended along and covered the chambers, but not crossing the sutures, sutures radial in the early stage, but straight, horizontal to slightly depressed in the uncoiled uniserial stage, aperture not described, probably terminal.

Remarks: This species differs from *Vaginulinoides fingeri* Anan by its compressed test, than globular chambers of the test.

Chrysalogonium asperum Cushman & Stainforth, 1945, p. 26, pl. 16, figs. 11, 12. Oligocene. Trinidad, Ivorian Basin.

Chrysalogonium laeve Cushman & Bermúdez, 1936, p. 27, pl. 5, figs. 1, 2. Maastrichtian-Miocene. USA, Caribbean, Ivorian Basin. This species differs from the genus's holotype by curved smooth slender test, weakly incised sutures.

Chrysalogonium vicksburgensis Todd, 1952, p. 13, pl. 2, figs. 13–15. Oligocene. USA, Ivorian Basin.

Amphimorphina haueriana Neugeboren, 1850 (=*Chrysalogonium cf. breviloculum* of Bignot, 1988, p. 441, pl. 1, fig. 12). Eocene-Miocene, Germany, Egypt, Ivorian Basin.

Awhea africana Anan, n. sp. (=*Chrysalogonium* cf. *tenuiscostatum* of Bignot, 1988, p. 441, pl. 1, fig. 12).

Holotype: Plate 1, Figure 10.

Etymology: after Ivorian Basin, west Africa, central Atlantic Ocean, Holes 960A and 960C, Ocean Drilling Program Leg 159 (Fig. 1).

Stratigraphic level: Middle Eocene (see Figure 4).

Diagnosis: Test calcareous narrow, elongate, uniserial rectilinear, with oval proloculus, followed by elongate subcylindrical chambers, sutures horizontal slightly constricted, surface ornamented with about twenty longitudinal ribs that may be slightly twisted about the vertical axis, aperture not described, probably terminal.

Remarks: This species differs from the holotype *Awhea sinalata* by more width test, and more number of the ribs (twenty than eight).

Nodosaria radicula (Linne, 1758)(=*Dentalina guttifera* of Bignot, 1988, p. 441, pl. 1, fig. 14). Eocene-Miocene. Austria, Germany, Hungaria, Ivorian Basin, Egypt, UAE.

Remarks: This figured specimen has rectilinear uniserial test without ornamented surface, chambers enlarging gradually as added, not as in the genus *Dentalina* with arcuate uniserial test with longitudinally costate surface.

Cushmanina striatopunctata (Parker & Jones, 1865)(= *Lagena crowlei*- of Bignot, 1988, p. 108, pl. 5, fig. 15). Oligocene. USA, Trinidad, Ivorian Basin.

Remarks: This species has ornamented test with nine longitudinal rows of 15 hollow pustulose, cone-shaped tubules, with narrow elongate neck, as in the genus *Cushmanina* Jones (1984)

Suborder Rotaliina Delage & Hérouard, 1896

Bulimina glomarchallengeri Tjalsma & Lohmann, 1983, p. 25, pl. 13, figs. 8-12. Eocene. Atlantic, Ivorian Basin.

Bulimina impendens Parker & Bermudez, 1937, p. 514, pl. 58, figs. 7, 8. Eocene-Miocene. Cuba, S. Atlantic, IB.

Bulimina macilenta Cushman & Parker, 1939, p. 42, pl. 7, figs. 7,8. Eocene. USA, Egypt, UAE, Ivorian Basin.

Bulimina semicostata Nuttall, 1930, p. 274, pl. 23, figs. 15, 16. Eocene. Mexico, Cuba, S. Atlantic, Spain, IB.

Bulimina trinitatensis Cushman & Jarvis, 1928, p. 102, pl. 14, fig. 12. Eocene. Caribbean, S. Atlantic, Spain, Ivorian Basin.

Uvigerina rippensis Cole, 1927, p. , pl. 2, fig. 16. Caribbean, N. Atlantic, W. Europe, Libya, Egypt, UAE.

Uvigerina spinosa Boersma, 1984, p. 160, pl. 62, figs. 3,4. Eocene. Ivorian Basin.

20a, b. *Pseudobuliminella africana* Anan, n. sp. (=*Rectuvigerina mexicana* of Bignot, 1988, p. 442, pl. 2, figs. 14-16).

Holotype: Plate 1, Figure 20a.

Paratype: Plate 1, figure 20b.

Etymology: after Ivorian Basin, west Africa, central Atlantic Ocean, Holes 960A and 960C (ODP), Leg 159 (Fig. 1).

Stratigraphic level: Middle Eocene (Figure 5).

Diagnosis: This specimens are regarded here to the genus *Pseudobuliminella* de Klasz et al. (1964) due to high elongate triserial spire test (rectilinear or curvature), with sutural projection, smooth surface, and an elongate slit aperture in the final chamber face, not *Rectuvigerina* Mathews (1945) with has an early chambers triserial and later uniserial elongate test, ornamented by longitudinal costae, and aperture terminal on a neck.

Remarks: The holotype of this species has elongate rectilinear test, while the paratype has curvature test.

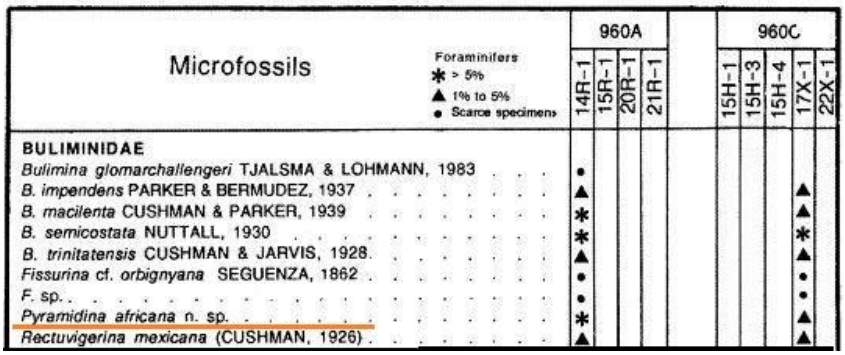

Figure 5: Distribution of microfossils in analyzed samples from Holes 960A and 960C, including the *Pseudobuliminella africana* Anan, n. sp.(=*Rectuvigerina mexicana* of Bignot, 1988).

Pyramidina africana Bignot, 1988, p. 438, pl. 3, figs. 1-11 (see Figure 5). Eocene. Ivorian Basin.

Turrilina robertsi (Howe & Ellis, in Howe 1939). Eocene. USA, Ivorian Basin.

Nonion florinensis (Cole, 1927) (=*Florilus florinensis* of Bignot, 1988, p. 443, pl. 3, fig. 17). Eocene. Mexico, IB.

Nonion havanense Cushman & Bermúdez, 1937, p. 19, pl. 2, figs. 13, 14. Eocene. USA, Caribbean, Ivorian Basin.

Pullenia eocenica Cushman & Siegfus, 1939, p. 81, pl. 7. fig. 1. Eocene-Miocene. USA, Caribbean, France, Spain, Ivorian Basin, UAE, Arabian Sea, Pakistan, New Zealand.

Anomalinoides semicribrata (Beckmann, 1954), p. 400 pl. 27 fig. 3. Eocene-Oligocene. Barbados, Ivorian Basin.

Nuttallides truempyi Nuttall, 1930, p. 287, pl. 24, figs. 9, 13, 14. Eocene. Mexico, Barbados, Trinidad, Atlantic Ocean, Italy, Ivorian Basin, Egypt, UAE, Pacific Ocean.

Cibicidoides grimsdalei (Nuttall, 1930), p. pl. 7, figs 1,2. Eocene. Mexico, Ivorian Basin.

Osangularia pteromphali (Gümbel, 1868). Eocene . Armenia, Ivorian Basin.

Nodosarella africana Anan, n. sp. (=*Nodosarella* cf. *advena* of Bignot, 1988, p. 444, pl. 4, fig. 6).

Holotype: Plate 1, Figure 30.

Etymology: after Ivorian Basin, west Africa, central Atlantic Ocean, Holes 960A and 960C (ODP), Leg 159 (Fig. 1).

Stratigraphic level: Middle Eocene (Figure 6).

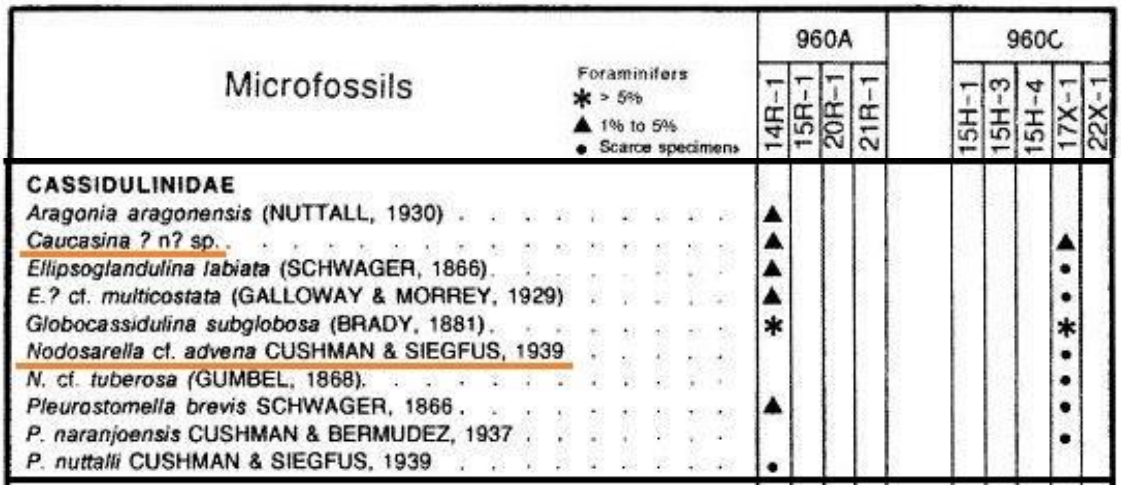

Figure 6: Distribution of microfossils in analyzed samples from Holes 960A and 960C, including the *Caucasina africana* Anan, n. sp. (*Caucasina ?*n. sp.) and *Nodosarella africana* Anan, n. sp.(=*Nodosarella* cf. *advena* of Bignot, 1988).

Diagnosis: Test smooth elongate and circular in section, chambers inflated uniserial curvature.

Remarks: This species differs from *N. advena* by curvature test (not rectilinear), and more number of chambers.

Aragonia aragonensis Nuttall, 1930, p. 280, pl. 23, fig. 6. Eocene. Mexico, Caribbean, Venezuela, North Atlantic, Spain, Italy, Ivorian Basin, Egypt, New Zealand.

Pleurostomella brevis Schwager,1866, p. 239, pl. 6, fig. 81. Eocene. Germany, Hungaria, North Atlantic, Ivorian Basin.

Pleurostomella naranjoensis Cushman & Bermudez, 1936, p. 16, pl. 1, figs. 59, 60. Paleocene-Eocene. Cuba, Caribbean, Ivorian Basin.

Pleurostomella nuttalli Cushman & Siegfus,1939, p. 29, pl. 6, figs. 17, 18. Maastrichtian-Miocene. USA, North Atlantic, France, Sweden, Italy, Ivorian Basin, Egypt, Indian Ocean, Pacific Ocean.

Caucasina africana Anan, n. sp. (=*Caucasina* ? n? sp. of Bignot, 1988, p. 444, pl. 4, fig. 16). Eocene. Ivorian Basin.

Holotype: Plate 1, Figure 36.

Etymology: after Ivorian Basin, west Africa, central Atlantic Ocean, Holes 960A and 960C (ODP), Leg 159 (Fig. 1).

Stratigraphic level: Middle Eocene (Fig. 6).

Diagnosis: Test elongate fusiform shape, early chambers low trochospiral, later chambers regularly triserial, surface covered by small calcareous angled to semi-rounded granules, sutures distinct slightly depressed, aperture an elongate narrow loop extending up the face of the final chamber.

Remarks: The figured specimen (no. 16, *non* fig. 12) closely related to the genus *Caucasina.* It differs from the holotype *Caucasina oligocenica* Khalilov (1951) by small granular calcareous angled to semi-rounded granules (not smooth) surface.

Globocassidulina subglobosa (Brady, 1881)(=*Cassidulina subglobosa*), p. 60, pl. 54, fig. 17. Eocene. Mexico, Brazil, Spain, Ivorian Basin.

4. PALEOGEOGRAPHY

The paleogeographic distribution of the identified thirty six benthic foraminiferal species in the Paleogene succession of Ivorian Basin in west Africa, and other Tethyan countries is shown in Table (1).

Table 1: Paleogeographic distribution of the Early Eocene benthic foraminifera in some Tethyan localities: 1. USA, 2. Mexico, 3. Caribbean, 4. Venezuela, 5. Peru, 6. Brazil, 7. Atlantic, 8. Spain, 9. France, 10. Germany, 11. Sweden, 12. Austria, 13. Hungaria, 14. Italy, 15. Ivorian Basin, 16. Angola, 17. Libya, 18. Egypt, 19. UAE, 20. Pakistan, 21. New Zealand. Sp. No. = Species number, x=recorded, - not recorded.

Sp. No.	Countries / species		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1	*Tritaxia*	*havanensis*	-	-	x	-	-	-	x	-	-	-	-	-	-	-	x	x	-	-	-	-	-
2	*Vulvulina*	*haeringensis*	-	x	-	-	x	-	-	-	-	x	-	x	-	-	x	-	-	-	-	-	-
3	*Eggerella*	*palmerae*	-	x	-	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-
4	*Karreriella*	*siphonella*	-	-	-	-	-	-	-	-	-	x	-	-	-	-	x	-	-	-	-	-	-
5	*Vaginulinoides*	*africana*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-
6	*Chrysalogonium*	*asperum*	-	-	x	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-
7		*laeve*	x	-	x	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-
8		*vicksburgensis*	x	-	-	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-
9	*Amphimorphina*	*haueriana*	-	-	-	-	-	-	-	-	x	-	-	-	-	-	x	-	-	-	-	-	-

Table 1 (Cont.): Paleogeographic distribution of the Early Eocene benthic foraminifera in some Tethyan localities: 1. USA, 2. Mexico, 3. Caribbean, 4. Venezuela, 5. Peru, 6. Brazil, 7. Atlantic, 8. Spain, 9. France, 10. Germany, 11. Sweden, 12. Austria, 13. Hungaria, 14. Italy, 15. Ivorian Basin, 16. Angola, 17. Libya, 18. Egypt, 19. UAE, 20. Pakistan, 21. New Zealand. Sp. No. = Species number, x=recorded, - not recorded.

10	*Awhea*	*africana*	-	-	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-
11	*Nodosaria*	*radicula*	-	-	-	-	-	-	-	-	-	x	-	x	x	-	x	-	-	x	x	-	-
12	*Cushmanina*	*striatopunctata*	x	-	x	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-
13	*Bulimina*	*glomarchallengeri*	-	-	-	-	-	-	x	-	-	-	-	-	-	-	x	-	-	-	-	-	-
14		*impendens*	-	-	x	-	-	-	x	-	-	-	-	-	-	-	x	-	-	-	-	-	-
15		*macilenta*	x	-	-	-	-	x	-	-	-	-	-	-	-	-	x	-	-	x	x	-	-
16		*semicostata*	-	x	x	-	-	-	x	-	-	-	-	-	-	-	x	-	-	-	-	-	-
17		*trinitatensis*	-	-	x	-	-	-	x	x	-	-	-	-	-	-	x	-	-	-	-	-	-
18	*Uvigerina*	*rippensis*	-	-	x	-	-	-	x	-	-	-	-	-	-	-	x	-	x	x	x	-	-
19		*spinosa*	-	-	-	-	-	-	-	-	x	-	-	-	-	-	x	-	-	-	-	-	-
20	*Pseudobuliminella*	*africana*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-
21	*Pyramidina*	*africana*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-
22	*Turrilina*	*robertsi*	x	-	-	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-
23	*Nonion*	*florinensis*	-	x	-	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-
24		*havanense*	x	-	x	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-
25	*Pullenia*	*eocenica*	x	-	x	-	-	-	-	x	x	-	-	-	-	-	x	-	-	-	x	x	x
26	*Anomalinoides*	*semicribrata*	-	-	x	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-
27	*Nuttallides*	*truempyi*	-	x	x	-	-	-	x	-	-	-	-	-	-	x	x	-	-	x	x	-	-
28	*Cibicidoides*	*grimsdalei*	-	x	-	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-
29	*Osangularia*	*pteromphali*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-
30	*Nodosarella*	*africana*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-
31	*Aragonia*	*aragonensis*	-	x	x	x	-	-	x	x	-	-	-	-	-	x	x	-	x	-	-	-	x
32	*Pleurostomella*	*brevis*	-	-	-	-	-	-	x	-	-	x	-	-	x	-	x	-	-	-	-	-	-
33		*naranjoensis*	-	-	x	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-
34		*nuttalli*	x	-	-	-	-	-	x	-	x	-	x	-	-	x	x	-	-	x	x	-	-
35	*Caucasina*	*africana*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-
36	*Globocassidulina*	*subglobosa*	-	x	-	-	-	x	-	x	-	-	-	-	-	-	x	-	-	-	-	-	-

Some remarks are presented:

Four agglutinated species represents (about 11%) of the total recorded benthic species (4/36), these are: *Tritaxia havanensis, Vulvulina haeringensis*, *Eggerella palmerae* and *Karreriella siphonella*.

Eight Lagenid calcareous species represents (about 22%), these are: *Vaginulinoides africana* Anan, n. sp., *Chrysalogonium asperum*, *C. laeve*, *C. vicksburgensis*, *Amphimorphina haueriana*, *Awhea africana* Anan, n. sp., *Nodosaria radicula* and *Cushmanina striatopunctata*.

Twenty five Rotaliid calcareous species represents (about 67%), these are: *Bulimina glomarchallengeri*, *B. impendens, B. macilenta, B. semicostata*, *B. trinitatensis*, *Uvigerina rippensis*, *Uvigerina spinosa, Pseudobuliminella africana* Anan, n. sp., *Pyramidina africana*, *Turrilina robertsi*, *Nonion florinensis, N. havanense*, *Pullenia eocenica*, *Anomalinoides semicribrata*, *Nuttallides truempyi, Cibicidoides grimsdalei*, *Osangularia pteromphali* , *Nodosarella africana* Anan, n. sp., **31.** *Aragonia aragonensis*, *Pleurostomella brevis*, *P. naranjoensis*, *P. nuttalli*, *Caucasina africana* Anan, n. sp., *Globocassidulina subglobosa*.

Five of the identified species (about 14%) are regarded here as a new species. These are: *Vaginulinoides africana, Awhea africana*, *Awhea africana*, *Nodosarella africana* and *Caucasina africana.*

According to the previous statistics, more than one species have wide geographic distribution around the world. Some species are recorded from more than five localities in the Tethys: *Nodosaria radicula, Uvigerina rippensis*, *Pullenia eocenica, Nuttallides truempyi, Aragonia aragonensis* and *Pleurostomella nuttalli.* Most of the identified species are recorded in five to two localities. *Pyramidina africana* and the five new species are, so far, an endemic to the original description in the Ivorian Basin.

The wide geographic distribution of the identified species emphasizes the interpretations that the Tethyan realm had been connected with the Atlantic Ocean to the west and the Indo-Pacific Ocean from the east, via Mediterranean sea, which are in accordance with some other authors, e.g.: Haque & Aubrey (1980), Solakius, (1990)(Figure 7).

Figure 7: The paleogeographic map of the terminal Cretaceous showing some Tethyan localities, from west to east: North Atlantic (USA, Mexico, Caribbean), Europe (France, Italy, Hungaria), Northeast Africa (Egypt), Southwest Asia (UAE) and Indian Ocean (Pakistan), after Solakius, (1990).

5. Paleoenvironment

Bignot noted that despite some important intervals without any recovery of the study area Holes 960a and 960c, of the Ivorian Basin, west Africa, central Atlantic Ocean, it appears that a long episode of strong carbonate dissolution was interrupted during Bartonian times by one or more sporadic and brief events of slight corrosion, and also suggested that the samples were deposited in middle-lower bathyal environments (at about 2 ± 1 km water depth), close to the lower limit of an oxygen minimum zone (Bignot, 1988). A group researchers noted that in the southern margin in the Tethys and including the outer-shelf -Bathyal deposits, the lower part of the Carbon Isotope Excursion (CIE) interval is associated with regional dysoxia (Aubry et al., 2007). Abed noted that the presence of Paleogene-Neogene marine environment supports the open flow direction of the Tethyan Circumglobal Current (TCC) in all directions, and the deep water agglutinated foraminifera, which may live around carbonate compensation depth "CCD", suggested a lower slope setting at about 1000 m water depth in an open marine basin (Figure 8) (Abed, 2013).

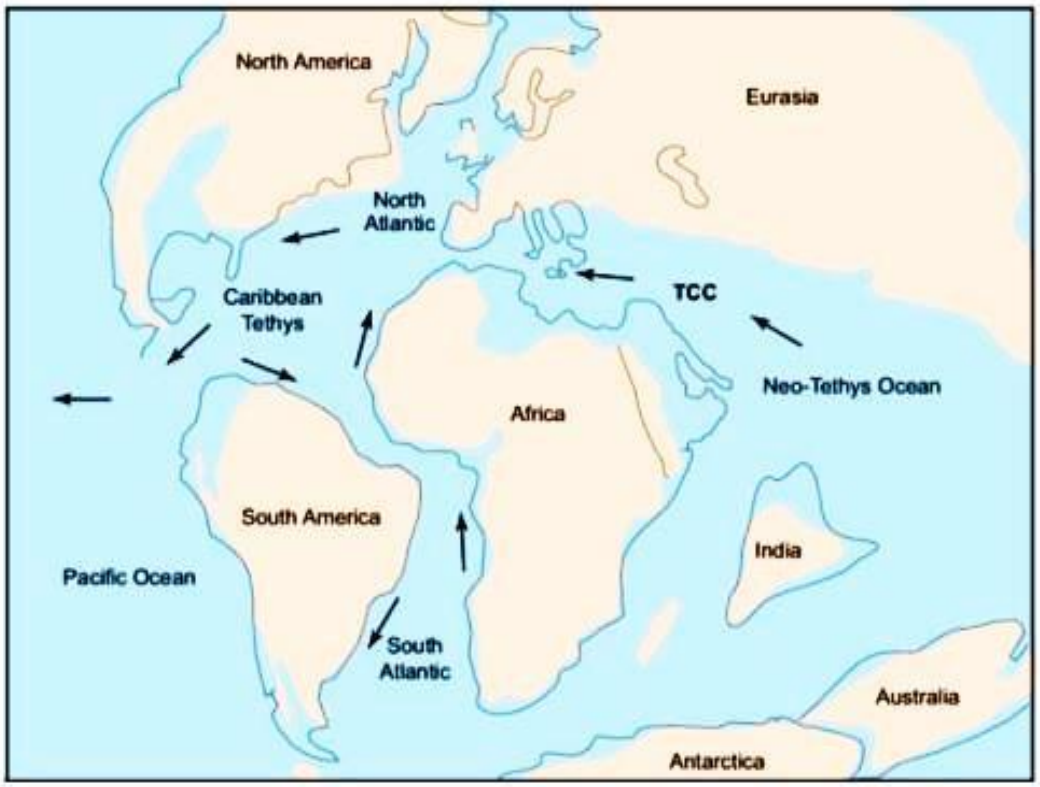

Figure 8: The Neo-Tethys ocean during the Late Cretaceous-Paleogene times showing the open flow direction of the Tethyan Circumglobal Current (TCC) in all directions (after Abed, 2013).

6. Conclusions

The present study deals with the recording of thirty six identified Paleogene species of agglutinated, Lagenid and Rotaliid calcareous foraminiferal genera from Ivorian Basin, west Africa. Five of the identified species are confined to Ivorian Basin, but the others were recorded from many localities in the North America (USA, Mexico, Caribbean), Southern Tethys (Venezuela, Peru, Brazil), Europe (Spain, France, Germany, Sweden, Hungaria, Italy), North Africa (Egypt), central and south Africa (Ivorian Basin, Angola), southwest Asia (UAE, Pakistan), and New Zealand. This study confirms again that the extended realms of the Tethys have extended from the Indo-Pacific to the Atlantic Oceans via Mediterranean Sea during the Paleogene time. Environmental conditions of the identified species represent outer shelf- Bathyal environment (~200-2000m).

Acknowledgement

The author thanks the editor of the ESMY for kind cooperation, and my daughter Dr. Huda Anan for her help in the development of the figures, table and plate.

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