

# Taxonomic Notes on Marker Benthic Foraminifera of Tomboy Field, Offshore Western Niger Delta, Nigeria

S. O. Obaje<sup>1</sup> and E. A. Okosun<sup>2</sup>

<sup>1</sup>Nigerian Geological Survey Agency, P.M.B. 1423, Fate, Ilorin, Kwara State, Nigeria

<sup>2</sup>Department of Geology, Federal University of Technology, P.M.B. 65, Minna, Niger State, Nigeria.

## ABSTRACT

The aim of the study is to identify and record the taxonomic notes on marker benthic foraminifera in the study area. The area of study is located in the Tomboy field of the offshore western Niger Delta area of Nigeria. In all, 550 ditch cuttings samples were retrieved at 18.29 meter intervals from the five wells studied (TMB-1, TMB-2, TMB-4, TMB-5 and TMB-6), respectively. The standard micropaleontological preparation technique for foraminiferal samples was employed. The benthic foraminifera were categorized into two groups, namely: benthic calcareous and benthic arenaceous/agglutinated foraminifera, respectively. TMB-1 well contained 1,188 calcareous benthic and 224 arenaceous benthic specimens, while 739 calcareous benthic specimens and 180 arenaceous benthic specimens were identified in TMB-2 well. On the other hand, 1,171, 1,099 and 1,325 calcareous benthic specimens and 250, 244 and 257 arenaceous benthic specimens were identified and counted in TMB-4, TMB-5 and TMB-6 wells, respectively. Total of thirty-five species were identified from the population distribution in the five wells and their taxonomic notes were properly recorded accordingly.

**Keywords:** Taxonomic notes, benthic foraminifera, Tomboy Field, western Niger Delta, Nigeria

## 1. INTRODUCTION

The area of study is located in the Tomboy field of the offshore western Niger Delta area of Nigeria (Fig. 1). The Niger Delta is situated in the Gulf of Guinea on the west coast of Central Africa. Niger Delta lies between latitudes 4° and 6° N and longitudes 3° and 9° E in the south-south geo-political region of Nigeria [13]. The Cenozoic Niger Delta is situated at the intersection of the Benue Trough and the South Atlantic Ocean where a triple junction developed during the separation of South America and Africa in the Late Jurassic [21]. The aim of the study is to identify and record the taxonomic notes on marker benthic foraminifera in the study area.

## 2. GEOLOGICAL SETTING

Three main formations have been recognized in the subsurface of the Niger Delta [10], [18], [20], [1], [19]. These

are the Akata, Agbada, and Benin Formations. These formations were deposited in marine, transitional and continental environments, respectively; together they form a thick, overall progradational passive-margin wedge [10]. The Akata Formation is Paleocene to Pliocene in age and it is the basal unit composed mainly of marine shales believed to be the main source rock within the basin. The Agbada Formation is made up of alternating sandstone, siltstone and shale sequences that constitute the petroleum reservoirs of the basin. Agbada Formation is Eocene to Quaternary in age (Figs. 2 and 3). On the other hand, the Benin Formation is Oligocene to Recent in age and it is mainly made up of non-marine fine to coarse-grained sands with a few mudstone and shaly intercalations [10].

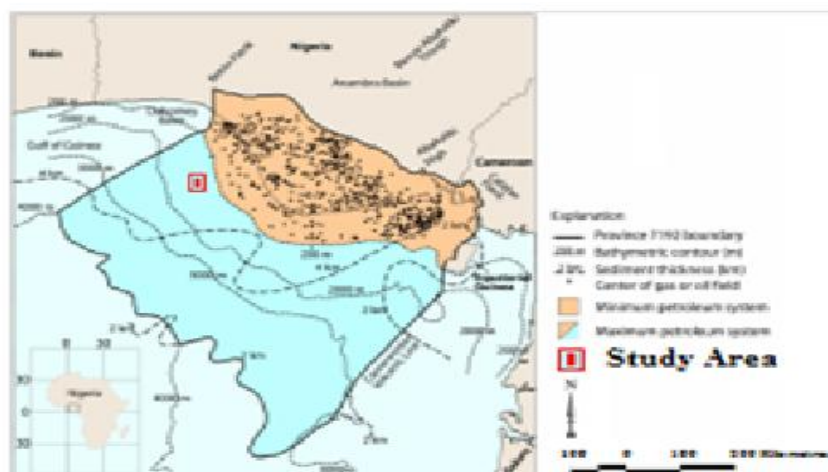


Fig. 1. Location Map of the Study Area (Source: Tuttle et al. [19])

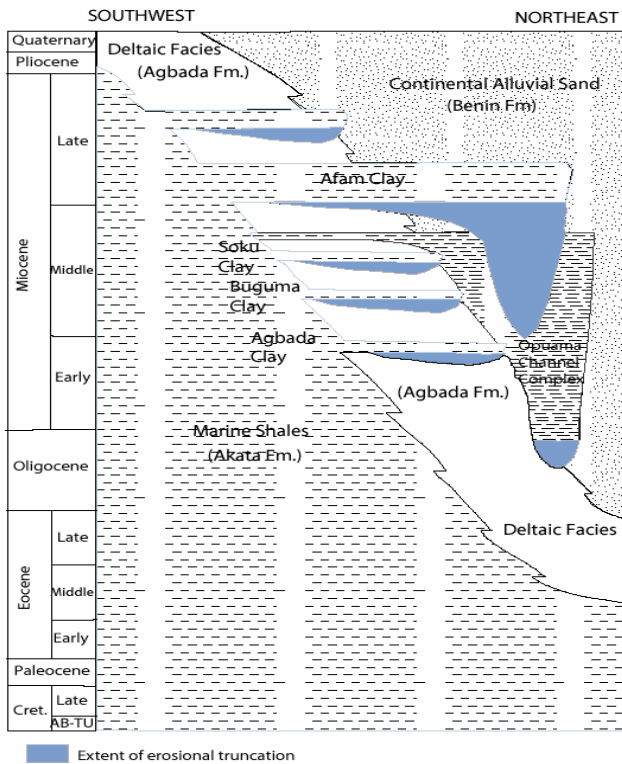


Fig. 2: Stratigraphic column showing the three formations of the Niger Delta (after Tuttle et al.[19]; modified from Doust and Omatsola [11])

were initially rinsed to remove drilling mud and then dried. Twenty grams of each dried sample was soaked for four hours in kerosene and then detergent solution water overnight. The disaggregated samples were then washed under running faucet water over a 63  $\mu\text{m}$  sieve mesh. The washed residues were then dried over a hot electric plate, and then sieved into three size portions: coarse, medium and fine. They were then put in labelled sample bags. Their foraminiferal contents were then identified under binocular microscope and recorded.

#### 4. RESULTS AND DISCUSSION

The systematics and taxonomic notes used in this study are based on published methods [8], [9], [12], [6], [16], [15], [14]. The listing of synonyms and detailed descriptions of species were omitted because the encountered species are well described in published literature some of which have been mentioned in this paper. In this study, the benthic foraminifera are categorized into two groups, namely: benthic calcareous and benthic arenaceous/agglutinated foraminifera, respectively. The benthic foraminifera in TMB-1 well are made up of 1,188 calcareous benthic and 224 arenaceous benthic specimens, respectively. In TMB-2 well, there are 739 calcareous benthic specimens and 180 arenaceous benthic specimens. TMB-4, TMB-5 and TMB-6 wells have 1,171, 1,099 and 1,325 calcareous benthic specimens and 250, 244 and 257 arenaceous benthic specimens, respectively. Within the population distribution in the five wells, a total of thirty-five species were identified and their taxonomic notes are given below, while their photomicrographs are shown in Plate 1. In this paper, family and sub-family names are in bold font, while the genus and species names are given in italic font in line with international standards.

##### 4.1 Arenaceous Benthic Foraminifera (FOBA)

**Order Foraminiferida** EICHWALD  
**Suborder Textulariina** DELAGE HÉROUARD  
**Superfamily Lituolacea** DE BLAINVILLE  
**Family Saccamininae** BRADY  
**Family Saccamininae** BRADY  
 Genus *Saccamina* (SARS)  
*Saccamina complanata* FRANKE (Plate 1.1)

##### Remarks

This form distinguished from *Reophax* in having a single globular chamber and a rounded aperture on a short neck.  
 Age: Silurian – Recent [9].

**Family Hormosinidae** HAECKEL  
**Subfamily Hormosininae** HAECKEL

Genus *Reophax* DE MONTFORT  
*Reophax* cf. *R. morrisoni* CUSHMAN & ELLISOR (Plate 1.2)

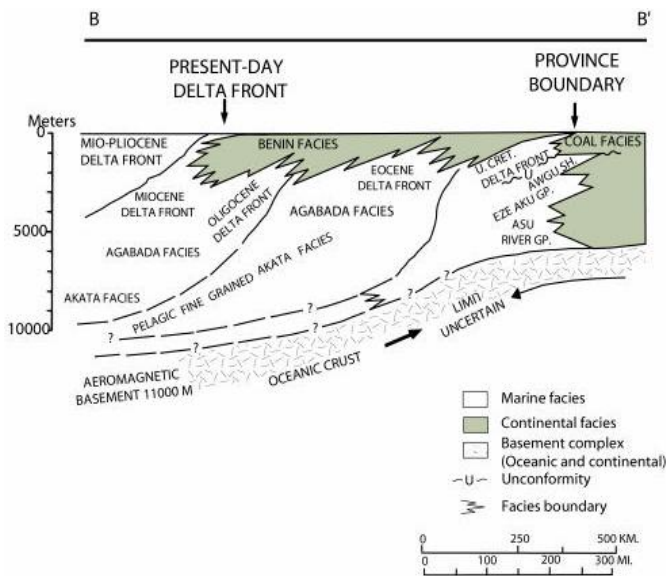


Fig. 3. Southwest-Northeast (B-B') cross-section through the Niger Delta (modified from Whiteman [21])

### 3. METHODS OF STUDY

In all, 550 ditch cuttings samples constituted by 113, 106, 111, 108 and 112 samples were retrieved at 18.29 meter intervals from the five wells studied (TMB-1, TMB-2, TMB-4, TMB-5 and TMB-6), respectively. The standard micropaleontological preparation technique for foraminiferal samples was employed. The unwashed ditch cutting samples



### Remarks

This species is distinguished from *Saccamina* and *Haplophragmoides* in having elongated, almost straight chambers and narrow, horizontal sutures. Like *Haplophragmoides*, its test is coarsely agglutinated.

Age: Pennsylvanian – Recent [9].

**Family Lituolacea** DE BLAINVILLE

**Subfamily Haplophragmoidinae** MAYNC

Genus *Haplophragmoides* CUSHMAN

Genotype: *Nonionina canariensis* D'ORBIGNY

*Nonionina* (part) D'ORBIGNY

*Haplophragmoides* cf. *H. hausa* PETTERS (Plate 1.3)

### Remarks

Unlike *Saccamina*, this species has planispiral, involute, arenaceous, agglutinated test and a simple aperture.

Age: Carboniferous – Recent [9].

**Subfamily Lituolinae** DE BLAINVILLE

Genus *Ammobaculites* CUSHMAN

Genotype: *Spirolina agglutinans* D'ORBIGNY

*Spirolina* (part) of authors

*Ammobaculites* cf. *A. jarvisi* CUSHMAN & RENZ (Plate 1.4)

### Remarks

This form has linear chambers with arenaceous wall and a simple, rounded terminal aperture.

Age: Middle – Late Miocene [16].

**Family Textulariidae** EHRENBERG

**Subfamily Spiroplectammininae** CUSHMAN

Genus *Spiroplectammina* CUSHMAN

*Textularia agglutinans* D'ORBIGNY var. *Biformis* PARKER & JONES

*Spiroplectammina* CUSHMAN

*Textularia* (part) PARKER & JONES (not DEFRANCE).

*Spiroplecta* BRADY (not EHRENBERG)

*Spiroplectammina carinata* CUSHMAN (Plate 1.5)

### Remarks

This species is similar to *Textularia* in having biserial chamber, arenaceous wall and an aperture at the base of the inner margin. However, it is distinguished from *Textularia* in having a distinct and well developed initial coil.

Age: Middle Oligocene – Early Miocene [17]; Middle Miocene [16].

**Subfamily Textulariina** EHRENBERG

Genus *Poritextularia* LOEBLICH & TAPPAN

*Textularia* sp. DEFRANCE (Plate 1.6)

### Remarks

The form is similar to *Poritextularia* in having a biserial, agglutinated test but it differs in having a multiple aperture that has no internal pillars and labrinthic structures.

Age: Middle Oligocene – Early Miocene [17], [12]; Middle Miocene [16].

**Family Trochamminidae** SCHWAGER

**Subfamily Trochammininae** SCHWAGER

Genus *Trochammina* PARKER & JONES

*Trochammina* cf. *T. pacifica* CUSHMAN (Plate 1.7)

### Description

This form is trochospiral test with slightly curved sutures. It has arenaceous agglutinated wall and an arched slit aperture on the ventral side of the chamber.

Age: Silurian – Recent [9].

**Subfamily Globotextulariinae** SCHWAGER

Genus *Eggerella* CUSHMAN

*Eggerella scabra* WILLIAMSON (Plate 1.8)

### Remarks

The form is similar to *Trochammina* cf. *T. pacifica* CUSHMAN in having trochospiral, arenaceous wall with slit aperture at the inner margin of the ventral side of chamber. However, it is different in having three chambers in a whorl and in having calcareous cement that makes it almost calcareous. Also, its aperture is made up of a lower arched slit than in *Trochammina* cf. *T. pacifica* CUSHMAN.

Age: Oligocene – Miocene [17].

## 4.2 Calcareous Benthic Foraminifera (FOBC)

**Suborder Miliolina** DELAGE & HEROUARD

**Superfamily Miliolacea** EHRENBERG

**Family Miliolidae** EHRENBERG

**Subfamily Quinqueloculininae** CUSHMAN

Genus *Quinqueloculina* D'ORBIGNY

Type: *Serpula seminulum* LINNÉ; LOEBLICH & TAPPAN [12]

*Quinqueloculina seminulum* LINNÉ (Plate 1.9)

### Remarks

This species is similar to *Quinqueloculina lata* TERQUEM in having three visible chambers from one side of the exterior and four visible ones from the opposite side. However, it is distinguished from *Quinqueloculina lata* TERQUEM in having bulbous, ovate chambers. Also, it is similar to *Quinqueloculina vulgaris* D'ORBIGNY in having ovate chambers but different in having three to four visible chambers. Its wall is calcareous, porcelaneous and imperforate and it has rounded, terminal aperture with bifid tooth.

Age: Late Miocene – Pliocene [17].



*Quinqueloculina microcostata* NATLAND (Plate 1.10)

Remarks

The test of this species is similar to *Q. seminulum* LINNÉ except for the presence of concentric microcostae ornamentation in the quinqueloculine test.  
Age: Middle – Late Miocene [16].

Genus *Sigmoilina* SCHLUMBERGER  
*Sigmoilina tenuis* ČŽJŽEK (Plate 1.11)

Remarks

This species resembles *Quinqueloculina microcostata* NATLAND, in having ovate chambers but differs in having sigmoid coiled chambers. Like *Quinqueloculina seminulum* LINNÉ, its wall is calcareous, porcelaneous and imperforate with rounded, terminal aperture with tooth.  
Age: Middle Eocene – Recent [12].

Genus *Spirosigmoilina* PARR  
*Spirosigmoilina oligoceanica* CUSHMAN (Plate 1.12)

Remarks

This species is similar to *Sigmoilina* in its sigmoid chamber arrangement and porcelaneous wall but differs in having a shorter neck.  
Age: Miocene [16].

**Suborder Rotaliina** DELAGE & HÉROUARD  
**Superfamily Nodosariacea** EHRENBERG  
**Family Nodosariidae** EHRENBERG  
**Subfamily Nodosariinae** EHRENBERG  
Genus *Nodosaria* LAMARCK  
*Nodosaria* sp. LAMARCK (Plate 1.13)

Description

This form is multilocular, rectilinear with distinct sutures. It has longitudinal striae ornamentation and a terminal aperture.  
Age: Miocene [16].

Genus *Amphicoryna* (SCHLUMBERGER)  
*Amphicoryna scalaris caudata* BATSCHE (Plate 1.14)

Description

The species is elongated and it has uniserial chambers. The sutures are horizontal, running perpendicular to the longitudinal costae ornamentation on the test. The terminal, radiate aperture is located at end of a slim, long neck.  
Age: Late Miocene [16].

Genus *Lenticulina* LAMARCK  
*Lenticulina inornata* D'ORBIGNY (Plate 1.15)

Remarks

This form has planispiral, bilaterally symmetrical test with terminal aperture like in *Lenticulina gratis* CUSHMAN. However, it differs from *Lenticulina gratis* CUSHMAN in having a transparent outer sheath on the test with slightly visible ornamentation.

Age: Early – Late Miocene [16].

Genus *Lagena* WALKER & JACOBS in KANMACHER  
*Lagena striata* D'ORBIGNY (Plate 1.16)

Description

The test is unilocular with longitudinal striae ornamentation. It has an aperture on an elongated neck with a phialine lip, which is not radiate.

Remarks

This form is similar to the species recorded by Petters [17].  
Age: Miocene – Pliocene [17].

*Lagena costata* WILLIAMSON (Plate 1.17)

Remarks

The specimen is similar to *Lagena striata* but differs in having concentric costae ornamentation on the test.  
Age: Middle Miocene [16].

Genus *Marginulina* D'ORBIGNY  
*Marginulina costata* BATSCHE (Plate 1.18)

Description

This form has rectilinear test with oblique sutures and a terminal, radiate aperture. It has distinct longitudinal costae ornamentation on the surface of the test.  
Age: Late Miocene [16].

Genus *Rectoglandulina* LOEBLICH & TAPPAN  
*Rectoglandulina comatula* LOEBLICH & TAPPAN (Plate 1.19)

Description:

This species has uniserial, rectilinear, inflated chambers. It has horizontal sutures and terminal, radiate aperture.  
Age: Middle – Late Miocene [16].

**Family Glandulinidae** REUSS  
**Subfamily Oolininae** LOEBLICH & TAPPAN  
Genus *Oolina* D'ORBIGNY  
*Oolina* sp. D'ORBIGNY (Plate 1.20)

Description:

This form has a single globular chamber with costae ornamentation on its test's surface. The aperture is rounded





with radiating surface grooves.  
Age: Jurassic – Recent [9].

**Superfamily Buliminacea JONES**

**Family Bolivinitidae CUSHMAN**

Genus *Brizalina* COSTA

*Brizalina* sp. LOEBLICH & TAPPAN [12] (Plate 1.21)

Remarks

This species differs from *Bolivina* in lacking crenulations or rectral processes. It is similar to *Bolivinoidea* in having longitudinal costae. Like *Bolivina*, it is biserial throughout with a straight test that is calcareous and perforated and it has a loop-shaped aperture with tooth plate.  
Age: Middle – Late Miocene of the Niger Delta [16].

**Family Eouvigerinidae CUSHMAN**

Genus *Stilostomella* GUPPY

*Stilostomella* sp. GUPPY, 1904 (Plate 1.22)

Remarks

This form differs from *Siphonodosaria* in having a single tooth or indentation. Also, it is different from **Nodosariidae** in having prominent apertural tooth, instead of a radial or slit aperture. Its test is uniserial, elongated and rectilinear with six subglobular chambers. It has calcareous, hyaline, perforated and spinose wall with terminal aperture.

Age: Middle – Late Miocene [16].

**Family Buliminidae JONES**

**Subfamily Bulimininae JONES**

Genus *Bulimina* D'ORBIGNY

*Bulimina aculeata* BROTZEN, PETERS [17], LOEBLICH & TAPPAN [12] (Plate 1.23)

Remarks

The test of species is calcareous and coarsely perforated. The aperture end with tooth plate, which has one shank free and the chambers are not strongly embraced like in *Globobulimina*.

Age: Paleocene – Recent [12].

**Family Uvigerinidae HACKAEL**

Genus *Uvigerina* D'ORBIGNY

*Uvigerina* D'ORBIGNY; PETERS [17]

*Uvigerina peregrina* CUSHMAN (Plate 1.24)

Remarks

Like *Uvigerina auberiana* D'ORBIGNY, this species has hispid ornamentation but differs in having this ornamentation restricted only to the apertural end and also in having distinct longitudinal striae ornamentation on the surface of the test. Like other species of *Uvigerina*, it has calcareous, perforated and flaring wall. Like *Uvigerina subperegrina* CUSHMAN &

KLEINPELL, it has a rounded, terminal aperture located on a short neck.

Age: Late Miocene [16].

*Uvigerina subperegrina* CUSHMAN & KLEINPELL (Plate 1.25)

Remarks

This form is similar to *Uvigerina peregrina* CUSHMAN but is less inflated and perforated. It has a rounded, terminal aperture located on a short neck.  
Age: Late Miocene [16].

*Uvigerina sparsicostata* CUSHMAN & LAI-MING (Plate 1.26)

Remarks

This form differs from *Uvigerina peregrina* CUSHMAN in having fusiform test with widely spaced longitudinal costae ornamentation. However, it is similar to *Uvigerina auberiana* D'ORBIGNY in having bulbous, fusiform test and a densely perforated wall with very tiny pores. Like other species of *Uvigerina* it has rounded, terminal aperture.

Age: Middle Oligocene – Early Miocene [17]; Middle - Late Miocene [16].

*Uvigerina auberiana* D'ORBIGNY (Plate 1.27)

Remarks

Like *Uvigerina sparsicostata* CUSHMAN & LAI-MING, this species has a fusiform test, with the maximum width around the middle of the test, and in having densely perforate wall with tiny pores. However, it differs in having closely spaced spinose or hispid ornamentation spread across the entire surface of its test. Like *Uvigerina peregrina* CUSHMAN, its neck is longer than that of *Uvigerina sparsicostata* CUSHMAN & LAI-MING.

Age: Middle Oligocene – Early Miocene [17].

**Superfamily Discorbacea EHRENBERG**

**Family Discorbidae EHRENBERG**

**Subfamily Baggininae CUSHMAN**

Genus *Cancris* DE MONTFORT

*Cancris auriculus* FICHTEL & MOLL (Plate 1.28)

Description

This species has trochospiral, auriculated and elongated shape. It is evolute on the spiral side, and it has calcareous, perforated wall. Its aperture is located on the umbilical side.

Age: Middle Miocene [16].

**Superfamily Rotaliacea EHRENBERG**

**Family Rotaliidae EHRENBERG**

**Subfamily Rotaliinae EHRENBERG**



Genus *Ammonia* BRÜNNICH  
 [*Nautilus beccarii* LINNÉ]  
*Ammonia beccarii* LINNÉ (Plate 1.29)

**Family Nonionidae** SCHULTZE  
**Subfamily Nonioninae** SCHULTZE

Genus *Florilus* DE MONTFORT  
*Florilus* ex. gr. *N. costiferum* CUSHMAN (Plate 1.33)

#### Remarks

It differs from *Nonion* in having a flaring test and from *Nonionella* in lacking the single umbilical chamber extension. However, it is similar to *Nonion* in having planispiral, asymmetrical, involute chambers.

Age: Middle to Late Miocene [16]

Genus *Nonionella* CUSHMAN  
*Nonionella* sp. CUSHMAN (Plate 1.34)

#### Remarks

This species differs from *Nonion* in having asymmetrical and trochospiral test and an asymmetrical final chamber.

Age: Middle Miocene [16].

**Superfamily Robertinacea** REUSS  
**Family Ceratobuliminidae** CUSHMAN  
**Subfamily Epistomininae** WEDEKIND

Genus *Hoeglundina* BROTZEN  
 [*Rotalia elegans* D'ORBIGNY]  
 [= *Hiltemannia* HOFKER  
 Type, *Epistomina chapmani* TEN DAM]  
*Hoeglundina elegans* D'ORBIGNY (Plate 1.35)

#### Remarks

This form is similar to the holotype emended by Loeblich and Tappan [12]. It is similar to *Epistomina* TERQUEM and *Epistominita* GRIGELIS in having early apertural slits and in having lenticular, trochospiral test with closed umbilical area. However, it differs in its lateromarginal and areal apertures.  
Age: Middle Jurassic to Recent [12]; Middle Miocene [16].

## 5. CONCLUSION

In this study, the aim was achieved. In all, 550 ditch cuttings samples constituted by 113, 106, 111, 108 and 112 samples retrieved at 18.29 meter intervals from the five wells were studied. The wells were designated as TMB-1, TMB-2, TMB-4, TMB-5 and TMB-6. The benthic foraminifera were categorized into two groups, namely: benthic calcareous and benthic arenaceous/agglutinated foraminifera, respectively. Thirty-five species were identified from the population distribution in the five wells and their taxonomic notes were properly recorded. The value of the taxonomic notes is to contribute to the study of these species and also to help other researchers in the study area in easy and time-saving identification of these species. Taxonomic notes help in

#### Description

This form has low trochospiral coil of 4 volutions. Its wall is calcareous and finely perforated with several irregular granules along its sutures and over its umbilical region.  
Age: Middle Miocene [16]

**Superfamily Orbitoidacea** SCHWAGER  
**Family Eponididae** HOFKER

Genus *Eponides* DE MONTFORT  
*Eponides eshira* DE KLASZ & RÉRAT

#### Description

This form is trochospiral with curved sutures on the spiral side. It has calcareous, finely perforated wall and its aperture lacks tooth plate.

Age: Middle Miocene [16]; Middle Oligocene – Early Miocene [15], [17].

**Family Cassidulinidae** D'ORBIGNY  
 [*Cassidulinidae* D'ORBIGNY in DE LA SAGRA]  
 Genus *Cassidulina* D'ORBIGNY  
*Cassidulina neocarinata* THALMANN (Plate 1.31)

#### Description

This form is carinated, biumbonate with central bosses. Its chambers are biserially arranged. It has calcareous, granular and perforated wall. Its aperture is located on the last chamber.

#### Remarks

This species differs from *Globocassidulina subglobosa* BRADY in lacking globular, non-keeled test and tripartite aperture.

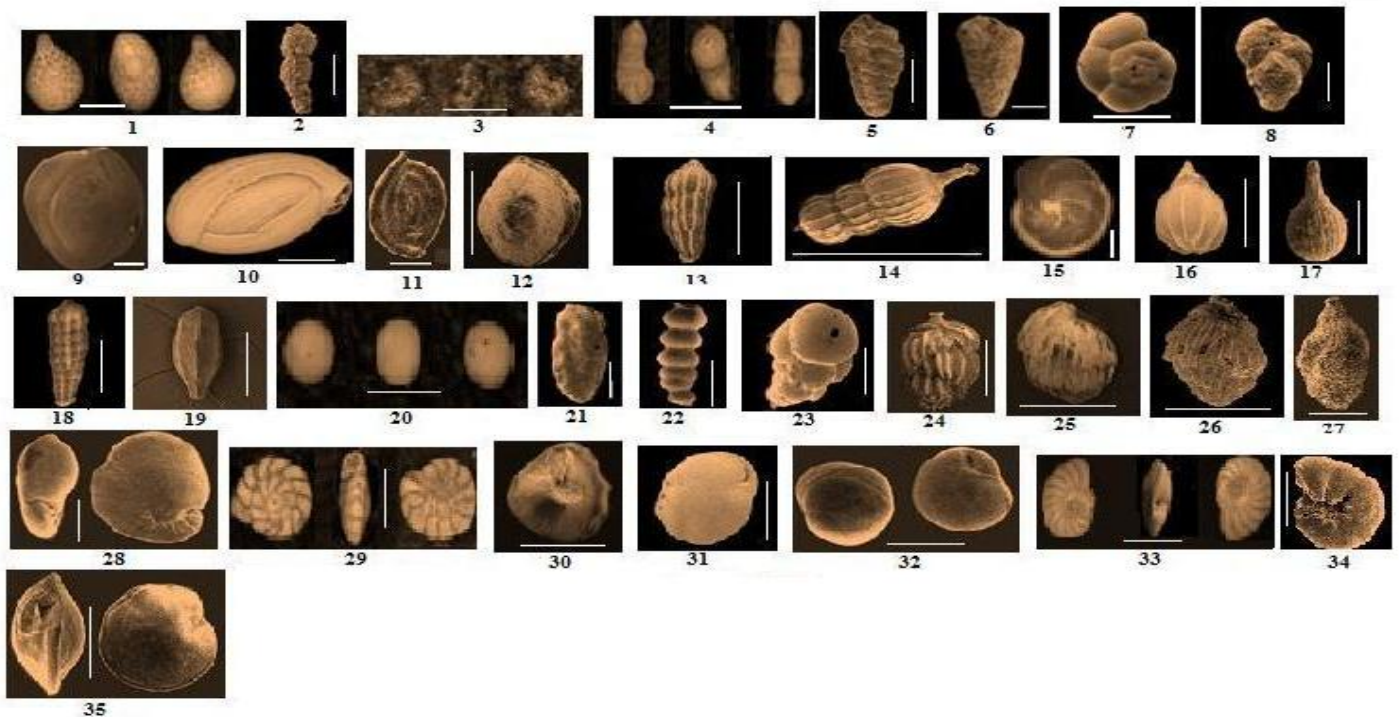
Age: Middle Miocene [16].

Genus *Globocassidulina* VOLOSHINOVA  
 [*Cassidulina subglobosa* BRADY]  
*Globocassidulina subglobosa* BRADY (Plate 1.32)

#### Remarks

This species differs from *Cassidulina neocarinata* THALMANN in having subglobular, non keeled test and a tripartite aperture on the last chamber, but similar in having biserial, calcareous, granular and perforated wall.  
Age: Late Miocene [16].

eradication of uncertainty and arbitrary identification of species.



- |  |  |
|--|--|
| 1. <i>Saccammina complanata</i> FRANKE                       | 18. <i>Marginulina costata</i> BATSCH                    |
| 2. <i>Reophax</i> cf. <i>R. morrisoni</i> CUSHMAN & ELLISOR  | 19. <i>Rectoglandulina comatula</i> LOEBLICH & TAPPAN    |
| 3. <i>Haplophragmoides</i> cf. <i>H. hausa</i> PETTERS       | 20. <i>Oolina</i> sp. D'ORBIGNY                          |
| 4. <i>Ammobaculites</i> cf. <i>A. jarvisi</i> CUSHMAN & RENZ | 21. <i>Brizalina</i> sp. LOEBLICH & TAPPAN               |
| 5. <i>Spiroplectammina carinata</i> CUSHMAN                  | 22. <i>Stilostomella</i> sp. GUPPY                       |
| 6. <i>Textularia</i> sp. DEFANCE                             | 23. <i>Bulimina aculeata</i> BROTZEN                     |
| 7. <i>Trochammina</i> cf. <i>T. pacifica</i> CUSHMAN         | 24. <i>Uvigerina peregrina</i> CUSHMAN                   |
| 8. <i>Eggerella scabra</i> WILLIAMSON                        | 25. <i>Uvigerina subperegrina</i> CUSHMAN & KLEINPELL    |
| 9. <i>Quinqueloculina seminulum</i> LINNÉ                    | 26. <i>Uvigerina sparsicostata</i> CUSHMAN & LAIMING     |
| 10. <i>Quinqueloculina microcostata</i> NATLAND              | 27. <i>Uvigerina auberiana</i> D'ORBIGNY                 |
| 11. <i>Sigmoilina tenuis</i> ČŽŽEK                           | 28. <i>Cancris auriculus</i> FICHTEL & MOLL              |
| 12. <i>Spirosigmoilina oligoceanica</i> CUSHMAN              | 29. <i>Ammonia beccarii</i> LINNÉ                        |
| 13. <i>Nodosaria</i> sp. LAMARCK                             | 30. <i>Eponides eshira</i> DE KLASZ & RÉRAT              |
| 14. <i>Amphicoryna scalaris caudate</i> BATSCH               | 31. <i>Cassidulina neocarina</i> THALMANN                |
| 15. <i>Lenticulina inornata</i> D'ORBIGNY                    | 32. <i>Globocassidulina subglobosa</i> BRADY             |
| 16. <i>Lagena striata</i> D'ORBIGNY                          | 33. <i>Florilus</i> ex. gr. <i>N. costiferum</i> CUSHMAN |
| 17. <i>Lagena costata</i> WILLIAMSON                         | 34. <i>Nonionella</i> sp. CUSHMAN                        |
|  | 35. <i>Hoeglundina elegans</i> D'ORBIGNY                 |

White Scale bars: 100  $\mu$ m

Plate 1. Photomicrographs of Marker Planktonic Species

## REFERENCES

- |   |   |
|---|---|
| [1] Avbovbo, A.A., 1978. Tertiary lithostratigraphy of Niger Delta, AAPG <i>Geol. Notes</i> , pp. 296-300.  | <i>Tertiary Stratigraphic Correlation</i> , Cambridge Univ. Press, pp. 61–151.  |
| [2] Blow, W.H. and Banner, F.T., 1962. The Mid-Tertiary (Upper Eocene to Aquitanian) Globigerinacea, in: Eames, F.E. Banner, F.T. Blow, W.H. and Clarke, W.J. (eds.), <i>Fundamentals of Mid-</i> | [3] Bolli, H.M., 1957. Planktonic foraminifera from the Oligocene-Miocene Ciperó and Lengua Formations of Trinidad, <i>B.W.I. Bull. Nat. Museum</i> , vol. 215, pp. 97–123. |



- [4] Bolli, H.M., 1966. Zonation of Cretaceous to Pliocene marine sediments based on planktonic foraminifera. *Boletín Informativo Asociación Venezolana de Geología, Minería y Petróleo*, vol. 9, no. 1, pp. 3–32.
- [5] Bolli, H.M., 1970. The foraminifera of Sites 23–31 Leg 4. *Rep. Deep Sea Drill. Proj.*, vol. 4, pp. 577–643.
- [6] Bolli, H.M. and Saunders, J.B., 1989. Oligocene to Holocene low latitude planktic foraminifera, in: Bolli, H. M., Saunders, J. B. and Perch-Nielsen, K. (eds.), *Planktonic stratigraphy, vol. 1: Plankton foraminifera, calcareous nannofossils and calpionellids*. (Cambridge Earth Sciences Series), Cambridge University Press, pp. 155–262.
- [7] Brönnimann, P., 1951. *Globigerinita naparimaensis* n. gen., n. sp., from the Miocene of Trinidad, B.W. I. *Contrib. Cushman Found. Foram. Res.* vol. 2, pp. 16–18.
- [8] Cushman, J.A., 1927. An outline of re-classification of the foraminifera. *Cushman Lab. Foram. Res. Contrib.*, vol. 3, part 4, pp. 1-105.
- [9] Cushman, J.A., 1969. *Foraminifera: their classification and economic use*, 4<sup>th</sup> ed., revised and enlarged with illustrated key to the genera. Harvard Univ. Press, USA, 604 pp.
- [10] Esan, A.O., 2002. High resolution sequence stratigraphic and reservoir characterization studies of D-07, D-08 and E-01 sands, Block 2 Meren Field, Offshore, Niger Delta, Publ. M.S. Geology Thesis, Texas A & M University, Texas, USA, 115 pp.
- [11] Doust, H. and Omatsola, E., 1990. Niger Delta. In Edwards, J.D. and Santogrossi, P.A. (Eds.), *Divergent/Passive Margin Basins*, *American Association of Petroleum Geologists Memoir* 48, pp. 201-239.
- [12] Loeblich, A.R. and Tappan, H., 1964. *Treatise on invertebrate paleontology, part C: Protista 2, Sarcodina chiefly: Thecamoebians and Foraminiferida*. Univ. Kansas Press for Geol. Soc. Amer., Lawrence, vols. 1 & 2, 900 pp.
- [13] Ojo, E.A., Fadiya, L.S. and Ehinola, O.A., 2009. Biozonation and correlation of BDX-1 and BDX-2 wells of deep offshore Niger Delta using calcareous nannofossils, *Search and Discovery Article (AAPG) no. 50194*, 8 pp.
- [14] Okosun, E.A., 2003. Taxonomic review of SPDC Niger Delta benthic foraminiferal type collection. Unpubl. SPDC Records, 62 pp.
- [15] Okosun, E.A. and Liebau, A., 1999. Foraminiferal biostratigraphy of eastern Niger Delta, Nigeria. *Nigerian Assoc. Petrol. Expl. Bull.*, vol. 14, no. 2, pp. 136–156.
- [16] Ozumba, M.B. and Amajor, L.C., 1999. Middle-to-Late Miocene biozonation of the western Niger Delta. *Nig. Assoc. Petrol. Expl. Bull.* no. 14, vol. 2, pp. 168–175.
- [17] Petters, S.W., 1982. Central West Africa Cretaceous-Tertiary benthic foraminifera and stratigraphy. *Palaeontographica Bd.* 179, Abt. A, pp. 1 – 136 .
- [18] Short, K.C. and Stäuble, A.J., 1967. Outline of Geology of Niger Delta, *American Association of Petroleum Geologists Bulletin* 5, vol. 51, pp. 761-779.
- [19] Tuttle, L.W.M., Charpentier, R.R. and Brownfield, E.M., 1999. The Niger Delta Petroleum System: Niger Delta Province, Nigeria Cameroon, and Equatorial Guinea, Africa, *U.S. Geological Survey Open-File Report 99-50-H*, Denver, Colorado, 70 pp.
- [20] Weber, K.J. and Daukoru, E., 1975. Petroleum Geology of the Niger Delta, *Proceedings of the 9<sup>th</sup> World Petroleum Congress*, Tokyo, vol.2, pp. 202-22.
- [21] Whiteman, A., 1982. *Nigeria- Its Petroleum Geology, Resources and Potential*, London, Graham and Trotman, p. 394.