British Journal of Earth Sciences Research

Vol.5, No.1, pp.37-53, August 2017

Published by European Centre for Research Training and Development UK (www.eajournals.org)

TAXONOMIC NOTES ON SOME MEMBERS OF GENUS *UVIGERINA* FROM THE DEEP OFFSHORE EASTERN NIGER DELTA NIGERIA

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ABSTRACT: *In an effort to give a systematic taxonomic account of benthic foraminifera from the Niger Delta, a total of 1,213 specimens of foraminifera were retrieved from 85 composite ditch cuttings samples from NEP-1 Well, off-shore eastern Niger Delta Nigeria. A detailed taxonomic appraisal of 140 specimens from the genus Uvigerina was carried out. The interval studied is 1750 meters thick, belonging to the Agbada Formation; lithologically, the section varies from shaly-sand to sandy-shale to shale. A genus of benthic foraminifera -Uvigerina d'Orbigny 1826, comprising of 4 species were identified, and described in details from this site, these includes Uvigerina peregrina Cushman 1923, Uvigerina bifurcata d'Orbigny 1839, Uvigerina hispida Schwager, 1866 and Uvigerina senticosa Cushman 1927. The fifth species (Uvigerina sp.) is identified to generic level and therefore described in open nomenclature.*

KEYWORDS: Genus, Assemblages, Stratigraphy, Diagnosis, Palaeontology

INTRODUCTION

The Tertiary Niger delta basin is situated along part of the Gulf of Guinea on the west coast of Africa. It lies between latitudes 40^o and 60^o N and longitudes 50^o and 8.50^o E (Fig. 1). It is a large arcuate delta of destructive wave-dominted type (Weber and Daukoru, 1975; Evamy et al; 1978). Niger delta basin is one of the sedimentary basins formed by the rift faulting of the Nigeria Precambrian rock (Evamy et al; 1978). Generally, because of its Hydrocarbon resources Niger delta is important; the delta started to evolve in Eocene period, due to the interplay between sediment supply and subsidence. Presently, deposition of sediments is still going on at the offshore. Niger Delta is a matured basin based on the exploration and exploitation of crude oil that have taken place there; it is a prolific oil province within the West Africa subcontinent. Since the first discovery of crude oil in 1956, many geological researches have been carried out, especially by oil companies. Microfossils such as Foraminifera provide chronostratigraphic control and a means of Paleoenvironmental information for the recognition of depositional sequences that develop in reactions to changes in relative sea level. Published results of these works include those on sedimentology (Short and Stauble 1967; Weber, 1971; Weber and Daukoru, 1975; Ejedawe, 1981, 1982; Stacher 1994), palynology of Tertiary sediments from tropical areas (Gemeraad et al., 1968), the palynomorphs in the paleoenvironments of some eastern Niger delta sediments (Mebradu, 2000), planktonic foraminifera in the Gulf of Guinea sediments (Adegoke et al., 1971) and Adegoke et al. (1976) on benthic foraminifera biofacies of the Niger Delta. Avbovbo (1978) studied the lithostratigraphy of the Niger Delta, while Petters (1982) studied the benthic foraminiferal biostratigraphy of the central West African Cretaceous sediments. Ojo and Salami (1992) worked on the Biostratigraphy of the Niger Delta; Ojo and Adebayo (2001) studied the miospore biostratigraphy of Agbada Formation, eastern Niger Delta basin. A detailed description of the stratigraphy and lithology of this formation, including its type section (interval in this study belongs to the Agbada Formation), has been presented by Short and Stauble (1967) and Avbovbo (1978). The present contribution gives a taxonomic account of

ISSN 2055-0111(Print), ISSN 2055-012X(Online)

the genus of *Uvigerina* from NEP-1 Well in the Agbada Formation, eastern Niger Delta basin, to provide better information on this genus *Uvigerina* and the few species encountered at this site, and around the Eastern Niger Delta, Nigeria and in a way compare same to related species across the globe .

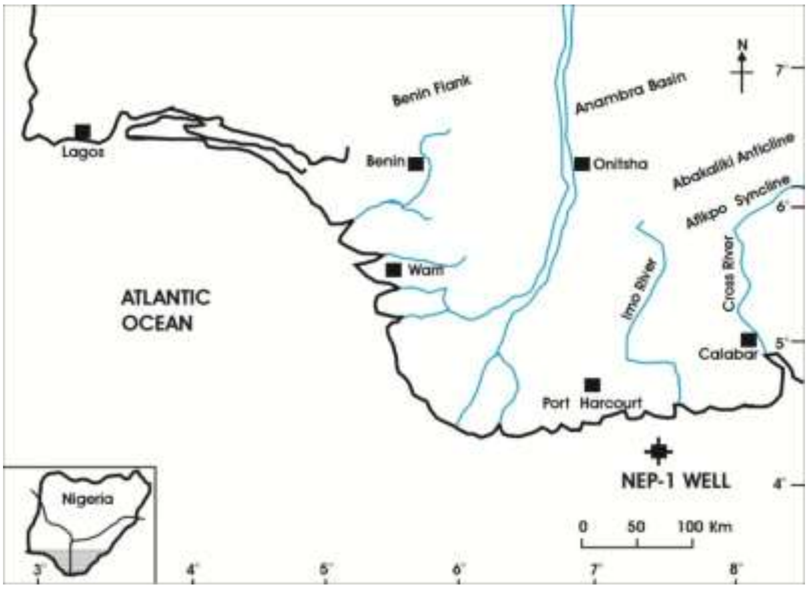

Figure 1 Map showing the location of NEP-1 offshore Niger Delta. Inset is the map of Nigeria, showing the location Niger Delta (Aturamu and Ojo, 2015)

Geological Setting

The present-day Niger delta Complex is situated on the continental margin of the Gulf of Guinea in the southern part of Nigeria (Fig. 1). It is bounded in the north by outcrops of the Anambra Basin and the Abakaliki anticlinorium; it is defined in the west by the Benin Flank – a northeast-southwest trending hinge line south of the West African basement massif. The Calabar Flank a hinge line bordering the Oban massif defines the northeastern boundary; the offshore boundary of the basin is defined by the Cameroon volcanic line to the east and the eastern boundary of the Dahomey Basin (the eastern-most West African transform-fault passive margin) to the west. The stratigraphy of Niger Delta includes the Benin, Agbada and Akata formations. These formations were deposited in environments which are continental, transitional and marine respectively; forming a thick, progradational passive-margin wedge (Esan 2002).

The stratigraphy of the Niger Delta is intimately related to its structure; the development of each being dependent on interplay between sediment supply and subsidence rate. Short and Stauble (1976) recognized three subsurface stratigraphic units in the modern Niger Delta. The delta sequence is mainly a sequence of marine clays overlain by parallic sediments which were finally capped by continental sands. Due to subsidence and deposition, a succession of transgressive and regressive sequence (circa 250 km) advance in the south west of the Niger delta (Oomkens, 1974). This resulted in the accumulated deposition of between 9,000 m to

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12,000 m thick transgressive and regressive sequences, which according to Curtis (1970) is similar to the Gulf Coast Tertiary section in the United State of America.

Lithostratigraphy

Short and Stauble (1976) classified the subsurface Niger delta into three basic stratigraphic units; Benin Formation which is the youngest, Agbada Formation and the oldest is Akata Formation. The Agbada Formation is the hydrocarbon - prospective sequence, a paralic clastic sequence which lies below the Benin Formation (continental sand) in the Niger delta. The shallowest part of this sequence is composed almost entirely of non-marine sand (Doust and Omatsola, 1990). The Agbada Formation consists of predominantly sandy units with minor shale intercalations and thick shale units at the base (which is an alternation of paralic sandstone, shale and clay). This sequence is over 4,000 m thick, but thicker at the central part showing that the depocentre is located in the cental Niger delta (Evamy et al. 1978).

The alternation of fine and coarse clastics provides multiple reservoirs-seal couplets, the paralic sequence is present in all depobelts, and the age ranges from Eocene to Pleistocene. A fluviatile origin is noted by the coarseness of the sand grains and its poor sorting (Fig. 2).

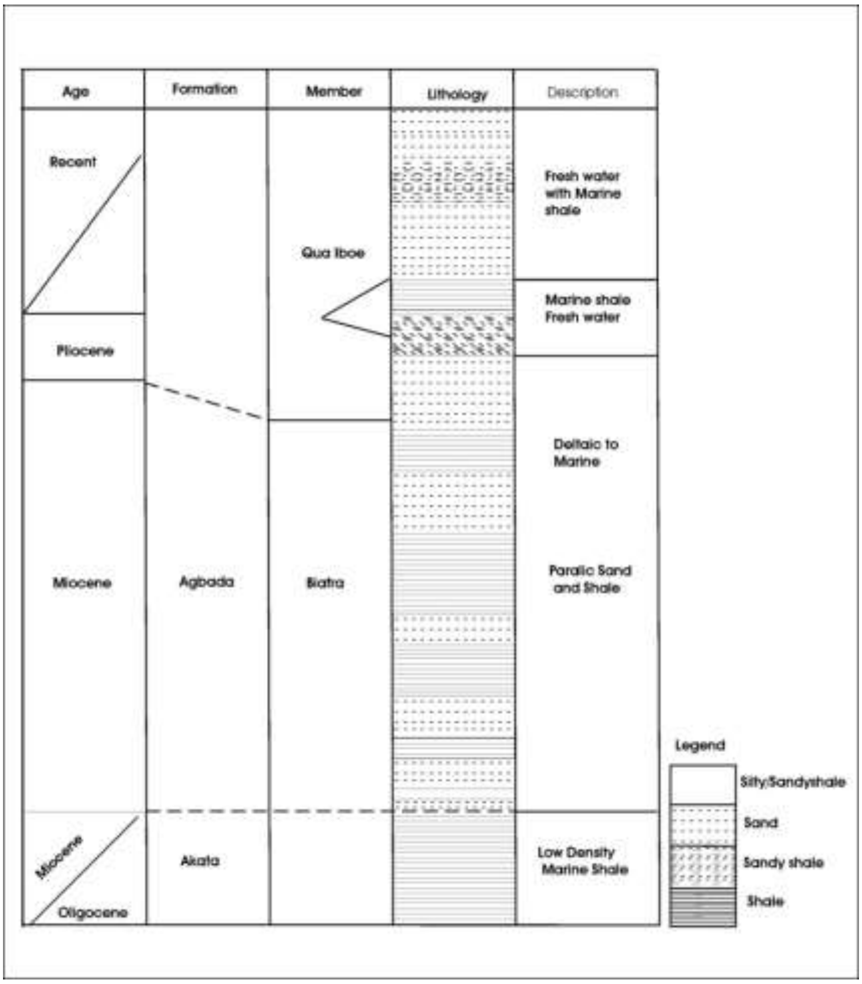

Figure 2 Generalized Stratigraphy of Eastern Niger Delta (Aturamu and Ojo, 2015)

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MATERIALS AND METHODS

A total of 85 composite ditch cuttings samples were selected from an interval range of 1750 m (i.e. the shallowest, at ~1400 m; the deepest, at ~3150 m) from NEP -1 well, located deep offshore, eastern Niger Delta. 25 grams of each sample were collected at each depth.

Samples were numbered sequentially according to increasing depth; and were later soaked in labelled beakers in a solution of 10% hydrogen peroxide for a period of 4-6 hours to allow proper disaggregation of the samples. Dissagregated sample were washed under a gentle current of tap water through a 63 µm mesh screen to liberate the microfossils, the residue were oven dried and stored in labelled vials before picking.

Because of the relative paucity of foramininfera in all the samples analysed, all available foraminifera specimens from each sample were picked into reference slides and later identified and counted using the Wild Heerbrugg M 18 binocular microscope. Most of the foraminifera identification was made to species levels where possible, using the taxonomic scheme Holbourn et al (2013) and other relevant foraminiferal literature. Other literatures include Bolli et al; (1985), Zacharinsse (1990) and Jones (1994).

Foraminiferal Assemblages

NEP-1 well contains fairly diverse foraminifera; a total of 1213 foraminiferal specimens were recovered from the sampled interval; 140 specimens from the genus were identified; 4 species were identified to species level, while only one species is identified in an open nomenclature. Genus *Uvigerina* comprise of 140 specimens; this makes up 11.5 % of the total foraminifera assemblage encountered at the NEP-1 Well. The diversity and abundance of the foraminiferal assemblages varied greatly throughout this interval. All the *Uvigerina* species are cosmopolitan, and are known mainly from the Atlantic, the Pacific Ocean and its environs.

Species identification is based mainly on the taxonomic works of McCulloch (1977); Kohl (1985); Van Morkhoven et al. (1986); Loeblich and Tappan (1987) for calcareous-walled taxa, Jones (1994); Gooday and Hughes (2002) and Holbourn et al. (2013), with reference made to other works where these are relevant. The classification is based mainly on test characters, as well as additional information on evolutionary relationships. Features considered of taxonomic importance include test composition and microstructure, mode of chamber and septal addition (including size), and apertural modification.

All photomicrographs (Plates 1-2) are based on specimens recovered from the NEP-1, Niger Delta, Nigeria

Systematic Palaeontology

Various species of *Uvigerina* identified from the NEP-1 Well are described in as much details as possible, though synonymy lists are not exhaustive; most entries in the lists being selective, based on well illustrated material (e.g, McCulloch 1977; Bolli et al; 1985, Zacharinsse 1990, Finger 1990, Jones 1994; Abu-Zied 2008 and Holbourn et al. 2013) or material considered to be of direct comparative

Family UVIGERINIDAE Haekel, 1894

Subfamily UVIGERININAE Haekel, 1894

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Genus *Uvigerina* d'Orbigny, 1826.

Type species *Uvigerina pygmaea* d'Orbigny

Uvigerina bifurcata d'Orbigny 1839

Plate 1, Figures 1-8, 11, 12, 13 and 15, Plate 2, Figures 1 and 2, 7, 8, 10, 12 and 16

Uvigerina bifurcata d'Orbigny, 1839, p. 53, pl. 7, fig. 17

Uvigerina pygmae d'Orbigny BRADY 1884, 74, figs. 13 - 14

Uvigerina bifurcata d'Orbigny; - THALMANN 1932, p. 306, pl. 74, figs. 13–14; - CUSHMAN 1947, p. 279, fig. 291; - BARKER, 1960, p.154, pl. 74, figs.13–14; - VAN DER ZWAAN et al. 1986, p. 226, pl. 16, figs. 4-6; pl. 17, figs. 1-4; - JONES, 1994, p. 86, pl. 74, figs. 13-14; - ABU-ZIED et al., 2008, p. 52, pl. 2, figs. 17-18.

Distribution in core: One of the dominant species, with 60 specimens in 18 samples between depths of 0 and 29.59 m.

Emended diagnosis: (based on Van der Zwaan et al. 1986, Jones, 1994 and Abu-Zied et al. 2008). Non-spinose *Uvigerina* with slender, elongate test; relatively high lamellar costae, non-serrate; proloculus pointed; aperture often with a spiral tooth.

Description: Test loosely triserial, elongate, typically stout with dimensions between 0.30 to 1.05 mm for maximal length excluding apertural neck, and between 0.20 to 0.48 mm for maximum transverse diameter; average length / breadth ratio is 2 (0.58/0.32); wall calcareous, weakly perforate; initial part of the first chamber is pointed; chambers mostly inflated and robust, particularly the later chambers, number of chambers varies with maturity from 5 to 9. Costae is usually non-serrate with relatively high lamellar forming a 'vault structure' on the test, number of heavy regular costae on the second to the last chamber varies from 4 and 9; costae sometimes end in spine-like projections at the base of the chamber, which might continue over the suture, the thickness of costae reduces on the last chambers towards the neck, proloculus pointed; aperture terminal with well-developed lip on a well-developed neck, having an inward projection of the inner portion of the neck wall into the aperture in the form of a spiral tooth, lip at the flattened side of the aperture. Arrangement of chambers tends to change from triserial to biserial in later stage of the test.

Remarks**:** *U. bifurcata* is differentiated from other *Uvigerina* species by the differences in the development of spines and pustules (e.g. *U. senticosa*). *U. celtica* Schönfeld is differentiated from *U. bifurcata* by its numerous small spines between the costae and its less inflated chambers (Schönfeld 2006). However, there are variations in the thickness of costae within the assemblage; ~ 70% of the specimens have relatively heavy regular costae through all the chambers, while the strength of costae reduces on the terminal chamber of others.

Distribution**:** *U. bifurcata* is a cosmopolitan species that has a geographical distribution in the Pacific (Schönfeld and Spiegler 1994; Lutze 1986; Jones 1994); Southern Ocean (Anderson 1975) and Atlantic (Chiessi et al. 2008; Lutze 1986), and bordering seas (e.g. Jones 1994; Burch and Burch 2007). This species has been recorded between 300 and 450 m water depth in the Atlantic Ocean (Lutze 1986). *U. bifurcata* is regarded as an infaunal species (Fontanier et al. 2002, 2006), and shallow infauna. The stratigraphical range of *U. bifurcata* is from the Pleistocene to Recent (Jones 1994).

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Uvigerina hispida Schwager, 1866

Plate 2, Figures 5 and 6

Uvigerina hispida Schwager, 1866 - BOERSMA, 1984, p. 76, pl. 1, figs. 1-4; - VAN MORKHOVEN et al., 1986, p. 62, pl. 20, figs. 1-4; - MILLER and KATZ, 1987, p. 140, pl. 2, fig. 2; - KATZ and MILLER, 1993, pl. 4, fig. 7; - ROBERTSON, 1998, p. 154, pl. 58, fig. 3; - KUHNT et al.; 2002, p. 158, pl. 14, figs. 5-7; - ORTIZ and THOMAS, 2006, p. 134, pl. 11, fig. 8: - KENDER et al., 2008b, pl. 18, figs. 6-8; - HOLBOURN et al., 2013, p. 592.

***Distribution in core*:** 12 specimens from 8 samples; intermittent occurrence down the core.

***Emended diagnosis*:** (Revised based on Holbourn et al., 2013 and material from the Bering Sea) Elongate *Uvigerina* with chambers that are densely ornamented with well-defined hispids (spines) that range from blunt to sharp.

***Description*:** Test is elongate, triserial, mostly sub-cylindrical in shape, fusiform, tapered at the periphery, circular cross-section; approximately two times as long as broad, average length ranges between 0.22 and 0.62 mm, width 0.18 and 0.24 mm; average length / width ratio is 2.2 (0.46 / 0.20), widest in the middle. Wall calcareous, perforate, ornamentation of densely spaced spines over each chamber, the spines varying from blunt to sharp in morphology; chambers mostly inflated and robust, particularly the later chambers, separated by distinctly depressed sutures; number of chambers varies on average with maturity from 5 to 8. Aperture is a terminal, round opening at the end of a relatively short neck, bordered by a phialine lip, and an internal toothplate.

***Remarks*:** Characters that are typical for, but not exclusive to, *U. hispida* include the stout test, compact, sub-cylindrical shape, fusiform, triserial coiling (that tends to become loose in the later chambers), and the number of chambers varying with maturity from 5 to 9. The circular aperture is situated on a short neck and bordered by a phialine lip, and contains an internal toothplate which is another distinctive character of *U. hispida* (see also Boersma 1984; Van Morkhoven et al. 1986 and description of Holbourn et al. 2013).

Holbourn (2013) interpreted the absence of the latter to be due to preservation, but data from this study implies that the presence/absence of this character varies intraspecifically There is variation in the strength of spines on individual chambers and these ranges from dense and acicular (needle-shaped) to blunt and coarse ornamentations. *U. hispaniolana* Bermúdez is morphologically similar to *U. hispida* but differs by having its sutures not depressed as in *U. hispida*. The chambers in *U. senticosa* are more inflated than in *U. hispida,* while the spines are not as pronounced (sharp) and high as it is in *U. hispida*.

Distribution: *U. hispida* is a cosmopolitan species that has a geographical distribution in the Atlantic, Pacific and Indian Oceans, the Gulf of Mexico and the Mediterranean Sea (Van Morkhoven et al. 1986; Kender et al. 2008; Holbourn et al. 2013) and other ocean regions (Holbourn et al. 2013). *U. hispida* has a bathymetric range that includes bathyal settings (Holbourn et al. 2013); its water depth ranges from 937 to 2539 m in the Gulf of Mexico, and 2489 to 3257 m in the Peru-Chile trench (LeRoy and Levinson 1974). *U. hispida* occurs as a shallow infaunal species (Corliss and Emerson 1990; Fontanier et al. 2002; 2003; 2006); the stratigraphical range of *U. hispida* is from Early Miocene to Recent (Boersma 1984c; Holbourn et al. 2013).

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Uvigerina senticosa Cushman 1927

Plate 1, Figures 10 and 14

Uvigerina senticosa CUSHMAN, 1927, p. 159, pl. 3, fig. 14; - CUSHMAN et al., 1930, p. 68, pl. 5, fig. 9; - CUSHMAN et al., 1949, p. 153, pl. 17, fig. 13; - BANDY, 1953, p. 177, pl. 25, fig. 12; - PIERCE, 1956, p. 1301, pl. 139, fig. 2; - SCHÖNFELD and SPIEGLER, 1993, pl. 1, figs 5 and 6.

Distribution in core: 16 specimens from 10 samples; intermittent occurrence between intervals 7.48 and 22.49 m; also at 24.25m.

Emended diagnosis*: Uvigerina* with chambers that are inflated and weakly hispid throughout; hispidity is low density and evenly distributed over the chambers, costae on the first chamber are divided into irregular hispids.

Description: Test robust, elongate, triserial, sub-cylindrical in shape, fusiform, circular cross-section, periphery lobate, approximately two and a half times as long as broad, average length ranges between 0.32 and 0.77 mm, width 0.20 and 0.30 mm; average length / width ratio is 1.9 (0.46 / 0.25), increasing in size, widest in the middle of the test. Wall is calcareous, moderately hispid throughout, hispidity being evenly distributed over the chambers. Chambers are more inflated than most other *Uvigerina* species, and are evenly graduated in size from the almost rounded initial end to the broadest towards the apertural end. Sutures are straight, oblique and depressed; aperture terminal with well-developed lip, having an inward projection of (the inner portion of) the neck wall into the aperture in the form of a spiral tooth lip at the flattened side of the aperture.

Remarks: Eastern Niger Delta material is morphologically similar to specimens recorded by Bandy (1953, pl. 25, figs. 12 a, b) from the California coast, and from the SE Pacific by Schönfeld and Spiegler (1993: pl.1, figs. 5, 6), by having the same number and arrangement of the chambers; *Uvigerina proboscidea* Schwager recorded from the California coast (Bandy 1953: pl. 25, figs. 11a, b), which has hispids, fairly elongated chambers and slightly straight sutural lines, is also morphologically similar to *U. senticosa*, but differs in having less inflated chambers. *Uvigerina auberiana* d'Orbigny is morphologically similar to *U. senticosa*, but is differentiated by its relatively broad cylindrical neck. Material from the Eastern Niger Delta shows intraspecific variation in the length of the apertural neck of specimens in the assemblage; the average length of the neck ranges between 0.04 - 0.1 mm; about 60% of the specimens have longer necks.

Distribution: *U. senticosa* has a geographical distribution in the Pacific Ocean (Schönfeld and Spiegler 1993), the coasts of Australia and California (Bandy 1953; Lowry and Smith 2003), and the Gulf of Mexico (Sen Gupta et al. 2009). Its water depth ranges from 351 - 800 m in the SE Pacific Ocean (Schönfeld and Spiegler 1993), to 3488 m in the Pacific to the east of Australia (Lowry and Smith 2003), up to 3657 m in the NE Pacific (Bandy 1953) and 0-3850 m at the Gulf of Mexico (Sen Gupta et al. 2009). The first record of *U. senticosa* is from the Recent of the eastern Pacific (Weldon 1970). It has since been recorded from the Miocene, Pliocene, and Pleistocene of California.

Uvigerina peregrina Cushman, 1923

Plate 2, Figures 3, 4, 9, 14 -16

ISSN 2055-0111(Print), ISSN 2055-012X(Online)

Uvigerina peregrina Cushman, 1923, p. 166, pl. 42, figs. 7-10; - PHLEGER and PARKER, 1951, p. 18, pl. 8, figs. 22, 24-26; - PARKER, 1954, p. 521, pl. 8 fig. 5; - MILLER and LOHMANN 1982, pl. 1, figs. 11-12; - BOERSMA, 1984, p. 124, pl. 1, figs. 1-4; - LUTZE, 1986, p. 32, pl. 1, figs. 1-6; - TIMM, 1992, p.67, pl. 6, fig. 2; - VAN LEEUWEN 1986, p. 59, pl. 1, figs. 1-5. p. 67, pl. 6, fig. 2; - SCHÖNFELD, 2006, p. 1, fig. 21; - LÉVY et al. 1998 p. 610, pl. 1, fig. 10; - KOUWENHOVEN, 2000, p. 197, pl. 11, figs. 1-2; - SCHÖNFELD, 2006, p. 354, pl. 1, figs. 14-18.

Distribution in core: 48 specimens in 16 samples; consistent occurrences at depth intervals 1.80 to 5.70 m; most abundant in the uppermost part of the NEP-1 Well.

Emended diagnosis: (Modified from description reproduced in Ellis and Messina, 1940) Test elongate, chambers usually numerous (up to 11). Wall ornamented with longitudinal costate, which become divided into spinose or irregular short portions; the wall between each costae is distinctly granular; aperture circular at the end of a distinct cylindrical neck, often spinose and with a phialine lip.

Description*:* Test elongate and stout, about 2 times as long as broad, widest in the middle, typically between 0.18 to 1.08 mm in length excluding neck; 0.15 to 0.44 mm diameter, average length / breadth ratio is 1.9 (0.62 / 0.32); later chambers inflated, more loosely triserial from side view, number of chambers varies with maturity from 4 to 11; sutures distinct and depressed. Longitudinal costae are distinct, and tend to become serrate and divide up into a series of plate-like spines or irregular short portions towards the younger chambers; wall calcareous, perforate, first and final chambers are mostly spinose, short series of pustules may be present between the costae, which may be coarse or fine. Aperture terminal, produced on a neck, which may be depressed at the base or not; aperture circular at the end of a distinct cylindrical / tubular and often spinose neck, aperture bordered with a lip having an internal projection like a toothplate at the flattened side of the aperture, with a phialine lip.

Remarks: *U. peregrina* was originally described by Cushman (1923) from a continental slope sample (~2100 m), off the northeastern United States. This is particularly important given that this interval is characterised by changes in seabed oxygen and nutrient levels (indicated from associated benthic faunas and occasional sediment laminations) that might have influenced subtle morphological changes in the test, as documented from other benthic foraminiferal assemblages (e.g. Thomas and Gooday 1996). In the assemblages, the length of the apertural neck varies randomly from 0.025 to 0.05 mm. The chambers are typically inflated, with the largest width often above the middle of the test. Costae vary from strong to weak on the chambers. The final chambers are generally hispid in all the assemblages, while the aperture is situated on an elongated neck, which may or may not be spinose.

The size of the test, shape of the chambers, length / width ratio, arrangement and morphology of costae are the main diagnostic features in differentiating this species from other *Uvigerina* species. *U. peregrina parva* Lutze is differentiated from *U. peregrina* by its smaller but uniform length, which ranges between 0.40 to 0.45 mm in adults (Schönfeld 2006), but resembles *Uvigerina peregrina* with its early and final chambers often being spinose. *U. dirupta* Todd has the same variation in test size and shape, but it is more slender with an average of 0.44 mm maximum transversal diameter (Van Leeuwen 1986). *U. pygmea* d' Orbigny (1826) has thin and low costae on the chambers, which may be partially serrate on the upper end of the lower

ISSN 2055-0111(Print), ISSN 2055-012X(Online)

chambers, and which are often smaller with few pustules between the costae. *U. peregrina* differs from *U. peregrina* var. *latalata* Stewart and Stewart in that the latter has fewer numbers of costae (usually 5 or 6) on fully grown chambers (Ellis and Messina 1940).

Distribution**:** *U. peregrina* has a geographical distribution from the Atlantic (Lévy et al. 1998; Schönfeld 2006) and Indian Oceans (Kurbjeweit et al. 2000; Schumacher et al. 2007), the Mediterranean Sea (Fontainer et al. 2008), Pacific (Joachim and Dorothee 1995; Keller 1980; Butt 1980), and other seas (e.g. Jorissen 1987). The characteristic water depth distribution of *U. peregrina* ranges from 900 to 3200 m (Haake 1980; Lutze 1980; Lutze and Coulbourn 1984). Its water depth range varies from 300 m in the Atlantic, having its shallowest reliable occurrences in the Gulf of Mexico (Pflum and Frerichs 1976), to 2496 m in the deep Guinea Basin (Timm 1992). A complete bathymetric succession of *Uvigerina* morphotypes from eastern North Atlantic has been described by Lutze (1986); *U. peregrina* is replaced progressively by another *Uvigerina* morphotype with spines between the costae and an entirely spinose last chamber (*U. hollicki* Thalmann) at 2000 m depth (Lutze 1986). Below 3000 m, *U. peregrina* is replaced by the spinose morphotype, *U.* hispida which became increasingly dominant (Van Leeuwen 1986).

Uvigerina **sp.**

Plate 1, Figure 9 and 16

Distribution in core**:** 4 specimens from 3 samples; first occurrence at 0 m, intermittent occurrence down core to 20.20 m.

Description**:** Test small, robust, small terminal neck, broken surface carinate; average length of test 0.32 to 0.45 mm, and width 0.20 to 0.32 mm, rounded in cross-section; chamber outlines and sutures indistinct, 11 to 12 longitudinal coarse costae on the chambers, prominent costae stop abruptly before getting to the base of the apertural neck; wall coarsely calcareous, micro perforate; aperture a round opening at the end of a depressed neck bordered with a lip.

Remarks**:** *Uvigerina* sp. is superficially similar to juvenile *U. bifurcata* in shape, coaste and rounded aperture, but is differentiated by the wall structure which is coarsely calcareous, and its apertural opening without a spiral tooth.

PLATES

Scale bar =100µm with the exception of Plate 1, figure 14 and Plate 2, figure 12 which are imaged at 50 µm)

PLATE 1

Plate 1, figs. 1-8, 11, 12, 13 and 15 (*Uvigerina bifurcata*)

Plate 1, figs. 9 and 16 (*Uvigerina* sp.)

Plate 1, figs. 10 and 14 (*Uvigerina senticosa*)

PLATE 2

Plate 2, figs.1 and 2 (*Uvigerina bifurcata*)

Plate 2, figs. 3, 4 and 9 (*Uvigerina peregrina*)

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Plate 2, figs. 5 and 6 (*Uvigerina hispida*)

Plate 2, figs. 7, 8, 10, 12 and 16 (*Uvigerina bifurcata*)

Plate 2, figs. 11 (*Uvigerina* sp.)

Plate 2, figs. 14, 15 and 16 (*Uvigerina peregrina*)

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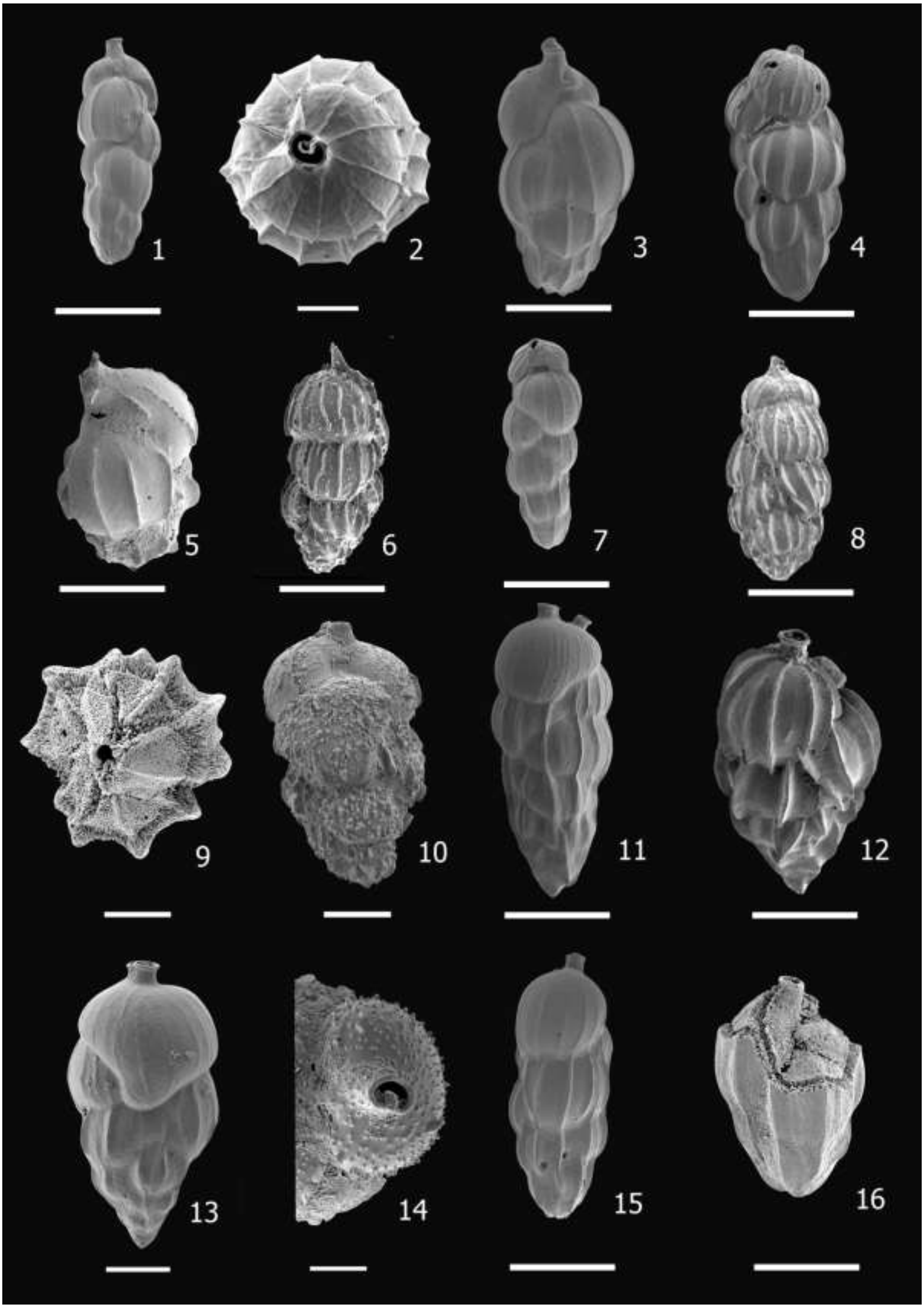

PLATE 1

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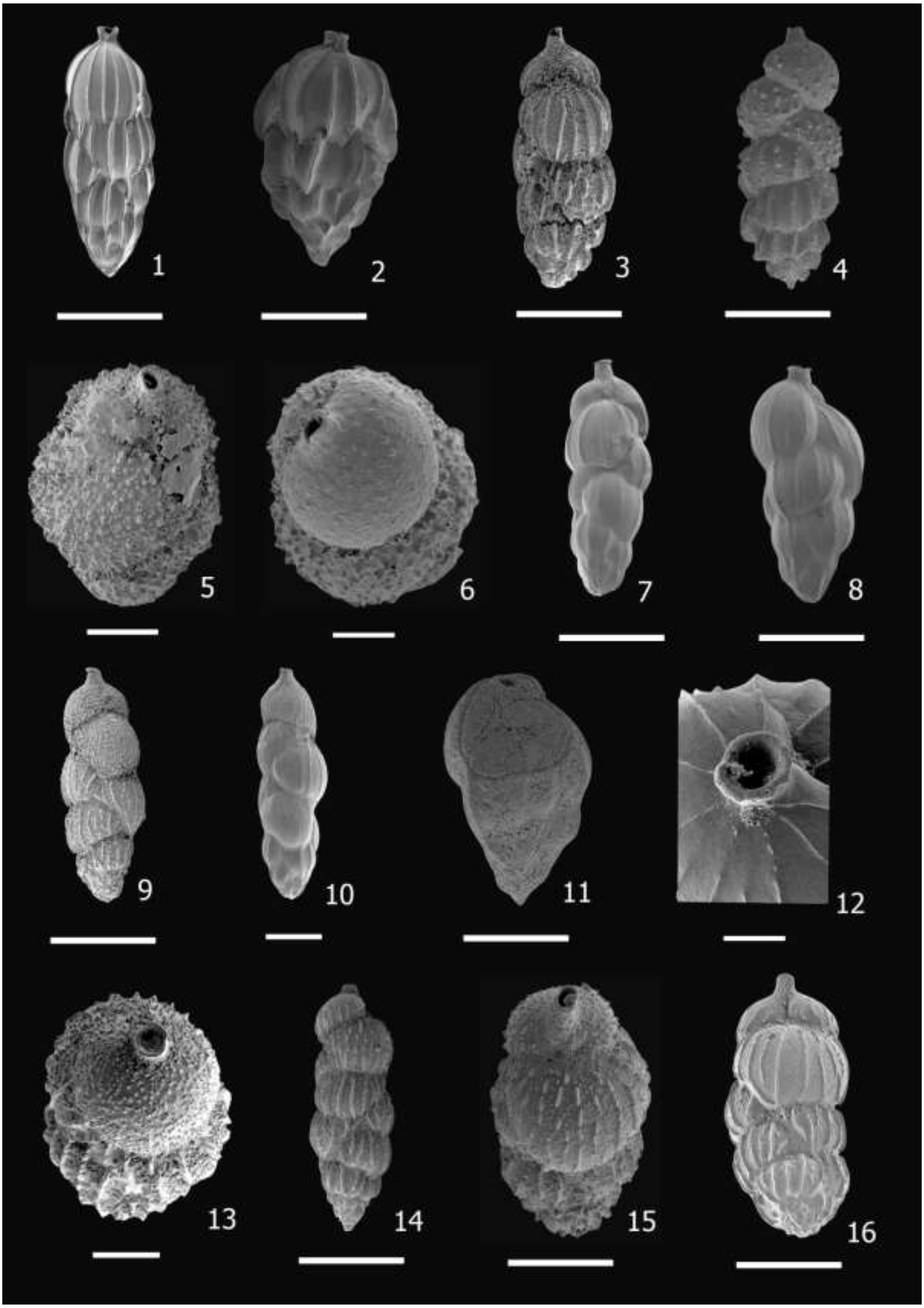

PLATE 2

ISSN 2055-0111(Print), ISSN 2055-012X(Online)

Acknowledgements

We acknowledge Shell Nigeria Exploration and Producing Company who released the samples for analysis. Ellis and Messina (1940) catalogues were consulted (during a research at the University of Leicester, UK) at the British Geological Survey, Keyworth, Nottingham, UK for the description of the original type species of the concerned specimens. Imaging of specimens was carried out by author at the Geology Department, University of Leicester, UK in 2014.

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