The Paleocene – Early Eocene Foraminiferal Biostratigraphy of Eastern Dahomey Basin,SW Nigeria

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ABSTRACT

The foraminiferal biostratigraphy of the Paleocene – early Eocene strata of SW Nigeria which represents the eastern Dahomey basin has been studied from four boreholes and two outcrops. A fairly diverse planktic and benthic foraminiferal assemblage was recovered.Six planktic biozones comprising *Praemurica pseudobulloides, P. inconstans, Morozovella angulata, Globanomalina pseudomenardii, Morozovella velascoensis* and *M. subbotinae* were identified. Two benthic concurrent range zones, *Anomalinoides uboniferus – Anomalinoides midwayensis* and *Planulina oyae* and *Uvigerina hourcqi* have been identified. These biozones will serve as useful correlation tools in the West African coastal and inland sedimentary basins.

INTRODUCTION

The boreholes and quarry section studied are in south western Nigeria (fig. 1) which represents the eastern Dahomey basin. The Gbekebo borehole is located on the Okitipupa ridge on the western flank of the Niger delta. The Araromi and Gbekebo boreholes penetrated the Cretaceous and Tertiary strata while other two boreholes BH No's 4925 and 1582 only penetrated part of the Tertiary sequence

Several workers have studied the geology and biostratigraphy of the Paleocene sequence in southwestern Nigeria (Berggren, 1960; Jones and

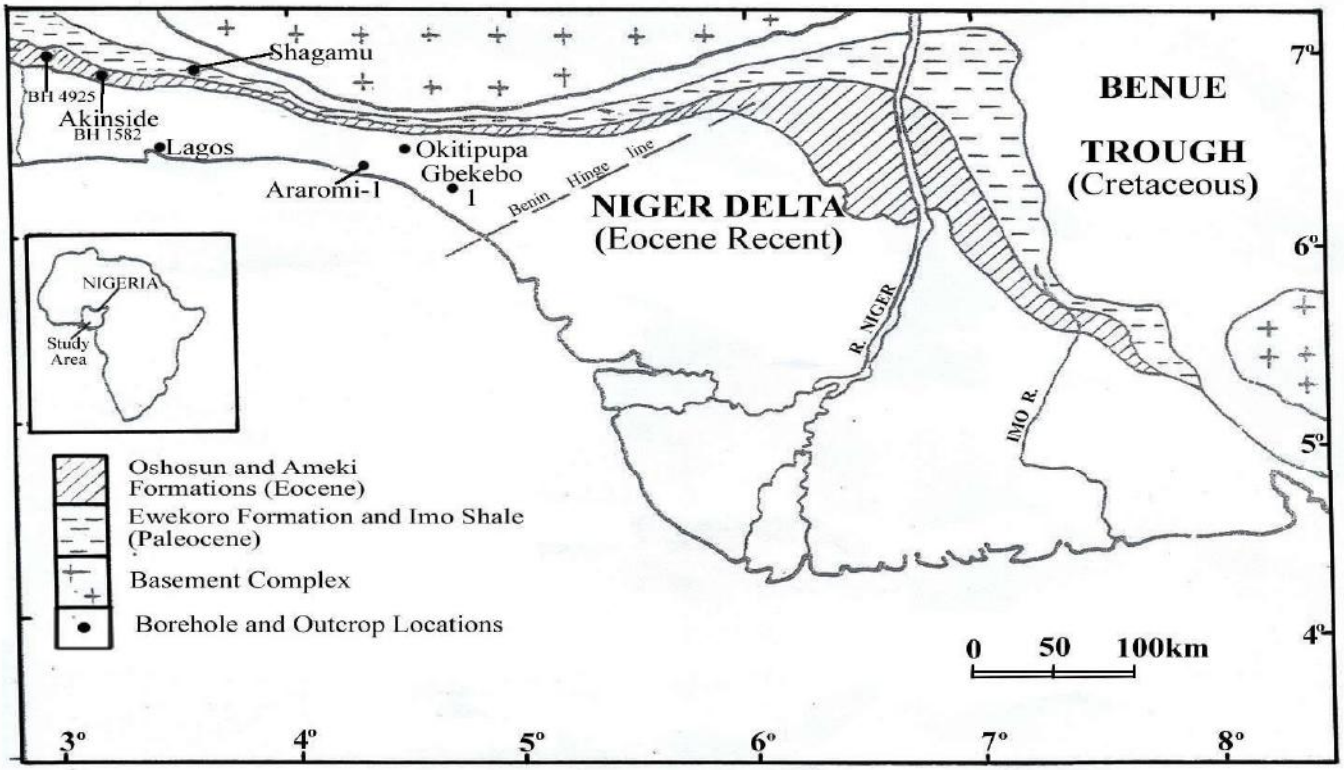


Fig. 1. Location map showing the study area and the distribution of Paleocene - Eocene Sediments in Southern Nigeria. (Adapted with modifications from Petters and Olsson, 1979)

Hockey, 1964; Kogbe, 1972; Ogbe, 1972, 1976; Adegoke, 1972, 1977; Adegoke *et al.,* 1971, 1972, 1976; Fayose and Assez, 1972; Petters and Olsson, 1979; Petters, 1982,

Okosun, 1987, 1989, 1998.And the objective of this study is to undertake a foraminiferal biostratigraphic study of the Paleocene –early Eocene strata of the eastern Dahomey basin.

LITHOSTRATIGRAPHY

The Paleocene – Eocene stratigraphic units in SW Nigeria comprises of Araromi, Ewekoro, Oshosun Formations and Imo Shale (Table 1 below).

A brief description of these units is given below.

Araromi Formation

The formation comprises of dark grey to black shale, shelly shale, sandy black shale and thin intercalations of limestones and sandstone (Okosun 1987, 1990). This formation was found in Araromi – 1 and Gbekebo – 1 borehole at 446 m – 583 m and 880 m – 1093 m respectively. The unit is equivalent to the Araromi Shale of Reyment (1965) and the Nkporo Shale of Billman (1976). The formation has an early Paleocene (Danian) age in SW Nigeria (Okosun, 1998).

Imo Shale

The Imo Shale is composed of grey, dark-grey and black shale with occasional white to brown sands (Okosun, 1998). Glauconite occurs sporadically in the formation. The shale is thinly laminated, and generally fissile and locally calcareous. The black shale facies was not encountered in the Gbekebo – 1 and Araromi – 1 boreholes, it appears to be restricted to the northern (inland) part of the basin. A maximum formation thickness of 178.4 m was reported for the northern part of the basin while 429m (from 421 m to 850 m) and 240 m (212 m to 454 m) have been reported from Gbekebo – 1 and Araromi – 1 boreholes respectively from the coastal area (Okosun, 1998).

Table 1: Correlation of early Tertiary Formations in Nigeria

Series	Stage	Inland SW	Coastal SW	SE	NW	NE
Eocene	Ypresian - Lutetian	Oshosun Fm	Oshosun Fm	Ameki Fm (Nanka Fm)		
Paleocene	Thanetian	Imo Shale	Imo Shale	Imo Shale; Ebenebe Sandstone; Umunna Sandstone; Igbalu Sandstone	Kalambaina Fm	Kerrikerri Fm
		Ewekoro Fm			Dange Fm	
		Imo Shale	Araromi Fm	Nsukka Fm		

Ewekoro Formation

The formation is exposed at the Larefag WAPCO quarries at Ewekoro and

Shagamu. At the Ewekoro quarry, the unit comprises of the following lithofacies: Basal sandy fossiliferous limestone, massive limestone nodular limestone and an uppermost glauconitic shale bed. The exposed section of the formation at the Shagamu quarry is composed of a basal nodular limestone bed that is followed by grey laminated shale, massive limestone, black shale and an uppermost massive fossiliferous limestone.
The formation was only encountered in the inland part of the basin. It was not found in the Araromi-1 and Gbekebo-1 boreholes. A maximum thickness of 47m has been reported for the formation. The base and top of the unit are marked by black and grey shale respectively (Okosun 1999).

Oshosun Formation

The formation comprises of green, greenish- grey or beige clay and shale with interbeds of sand. The shale is usually thickly laminated, calcareous and glauconitic. The associated sand is whitish, light brown or brownish grey in colour; it is predominantly medium to coarse grained with some fine grained horizons. The quartz grains are round, fine and clear, the sand is usually poorly sorted. Vesicular, nodular or compact phosphorites occur sporadically in the formation (Okosun, 1984). Thin limestone or marl beds are locally present in the formation (Russ, 1924; Reyment, 1965; Adegoke, 1969; Kogbe, 1976; Ako et al; 1981; Okosun,1998) the formation becomes arenaceous and calcareous towards the top and base respectively. Vertical and laterals lithofacies variations are common. A maximum thickness if 101.5m was reported for the formation (Okosun, 1998).

MATERIALS AND METHODS

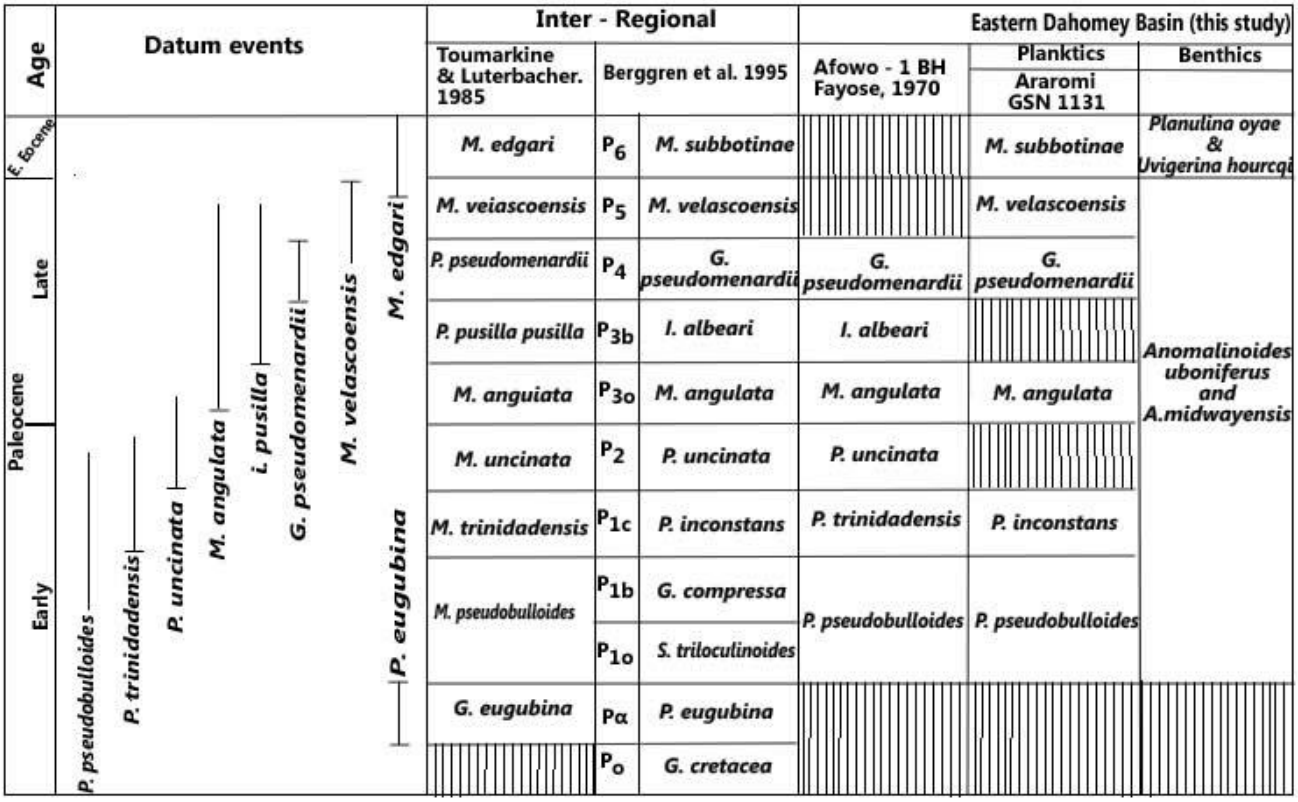
Samples for the study were collected from Araromi—1 borehole (GSN 1131), Gbekebo-1 borehole (GSN 1132), Akinside borehole (GSN 1582) Borehole No 4925, Ewekoro and Shagamu limestone quarries. The samples were collected at 2-3 meter intervals from the borehole core. The representatives' lithofacies samples were collected from the quarry faces.

The samples were disaggregated in a solution of 10% H_2O_2 overnight and boiled in a water with a pinch of soda ash. They were then washed through a 63μm sieve. The washing procedure was repeated until foraminifera with clean surfaces were obtained. All the foraminifera recovered from the residue were counted and studied under the microscope. Generic classification was based on Loeblich and Tappan(1988) Olsson et al (1992) and other relevant foraminifera literature. The species identification was based mainly on Toumarkine and Luterbacher (1985). Since the taxa encountered in this study have been described by some previous workers (Ako et al., 1980; Petters 1979, 1982 and Bolli, 1957) they have not been redescribed. Some of the species have been illustrated in plates 1-3.The illustrated specimens were deposited in the paleontological collections of the Universitatsstadt Tubigen, Germany.

Biostratigraphy

A fairly diverse foraminiferal assemblage of planktic and benthic species was recovered in this study. Their stratigraphic distribution is illustrated in figs 2-5. Majority of the foraminiferal species are illustrated in plates 1-4. From the first and last appearances of diagnostic species, six planktic foraminiferal biozones were recognized form the early Paleocene to the early Eocene (Table 2). The planktic foraminiferal zonal schemes adopted here are those by Tourmakine and Luterbacher (1985) and Berggren *et al.* (1995) for the early Tertiary. Two benthic foraminiferal biozones were recognized.

Table 2. Planktic and benthic foraminiferal biostratigraphy of the Eastern Dahomey Basin and correlation with the inter-regional schemes (modified after Obaidalla, 2000)



The proposed biozones are arranged from base to top.

Planktic Foraminiferal Zones

Parasubbotina pseudobulloides Zone

P_1a + P_1b sub zones (Berggren *et al.,* 1995)

Age: Earliest Paleocene

Author: Bolli (1966)

The partial range of the index taxon from its FAD to the LAD of *Praemurica trinidadensis* (Bolli) was used to define the zone (Bolli, 1966). The upper boundary is also correlated to the FAD of *Praemurica inconstans* (Subbotina) according to Berggren *et al.,* (1995). *Praemurica trinidadensis* (Bolli) was not found in the study area.

The dominant species in this zone are *Subbotina triloculinoides* (Plummer), *Globanomalina compressa* (Plummer), *Globoconusa danbjergensis* (Bronnimann) and *Eoglobigerina trivialis.* The *P. pseudobulloides* zone occurs in the Araromi – 1 and Gbekebo – 1 borehole (Fig. 2 & 3).

***Praemurica inconstans* Zone**

P. trinidadensis Zone (Toumarkine & Luterbacher)

Age: Early Paleocene

Author: Berggren *et al.,* (1995)

This zone was defined by Berggren et al., (1995) as sub-zone Pic based on the FAD of *P. inconstans* (Subbotina) to the FAD of *Praemurica ucinata* (Bolli). The dominant species in this zone are *Parasobbotina pseudobulloides* (Plummer), *Subbotina triloculinoides* (Plummer) and *Globanomalina compressa* (Plummer). The *P. inconstans* Zone occurs only in Araromi – 1 borehole. (fig. 2) The *P. ucinata* Zones of Toumarkine & Luterbacher (1985) and Berggren *et al.,* (1995) was not encountered in this study.

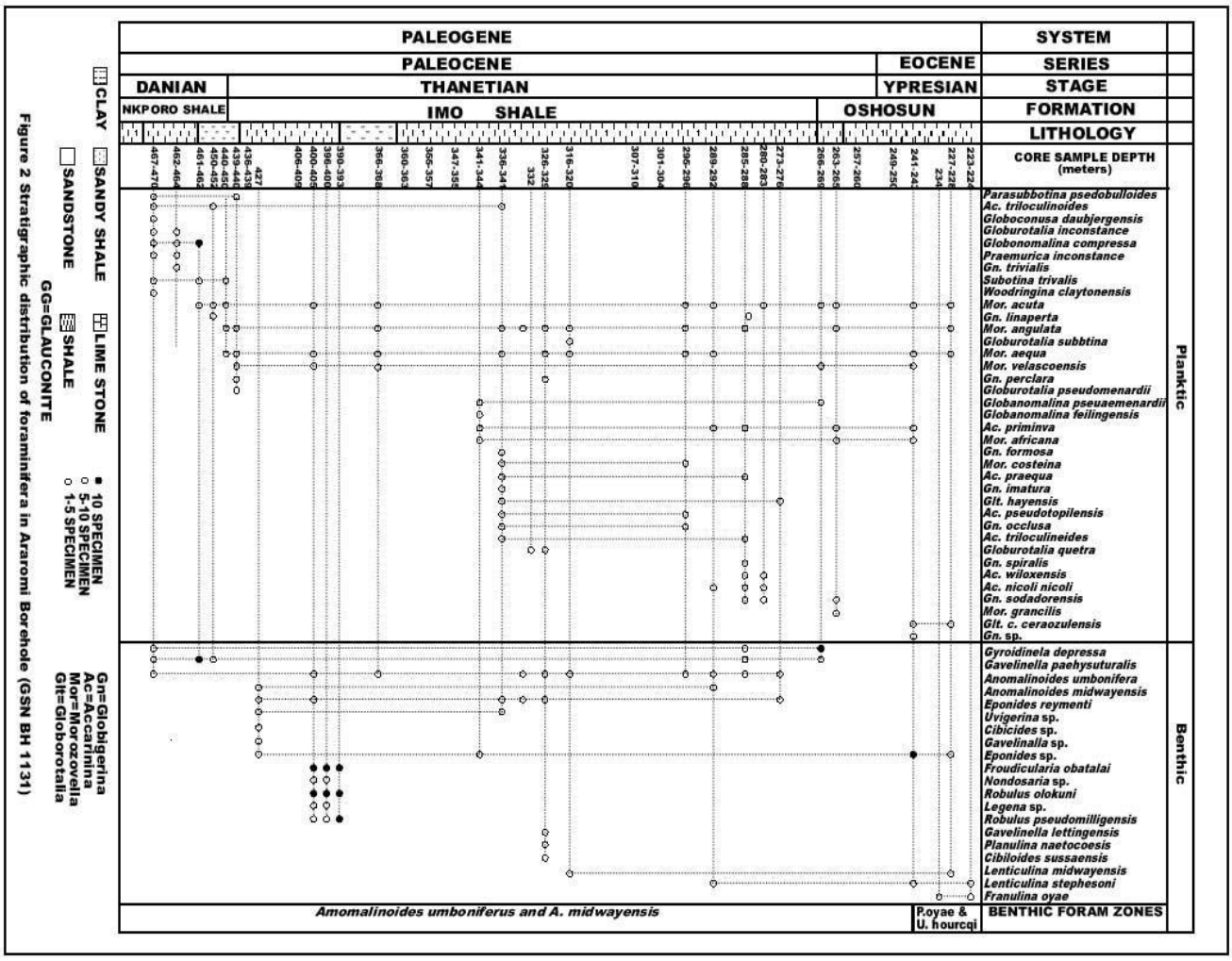


Figure 2 Stratigraphic distribution of foraminifera in Araromi Borehole (GSN BH 1131)

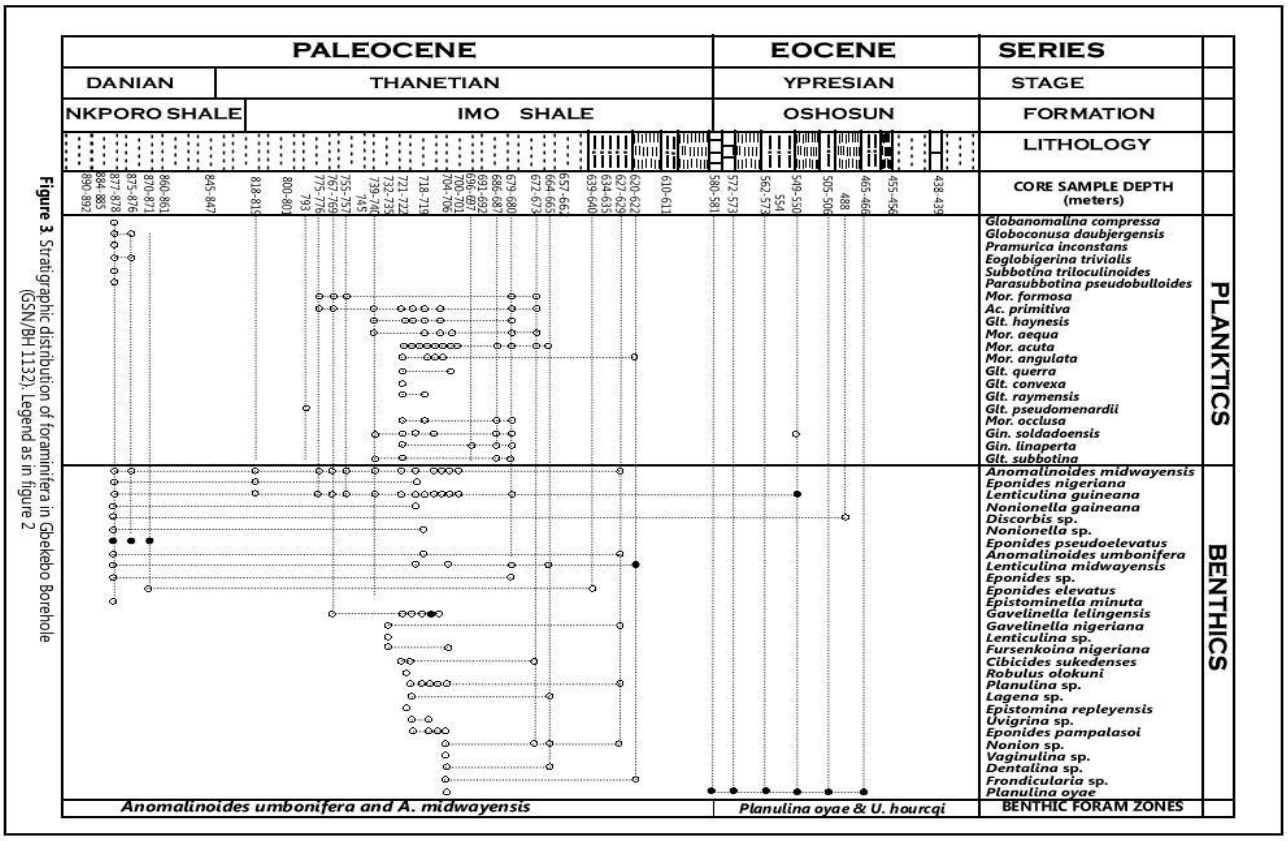


Figure 3 Stratigraphic distribution of foraminifera in Gbekebo Borehole (GSN/BH 1132). Legend as in figure 2

Morozovella angulata Zone

P3a subzone (Berggren *et al.,* 1995)

Age: Late Paleocene

Author: Hillebrandt (1965)

This zone has been defined as the partial range of *M. angulata* (White) from its FAD to the FAD of *Igorina pusilla* (Bolli). The top of this zone was defined by Berggren *et al,* (1995) based on the FAD of *Igorina albeari* (Cushman and Bermudez) instead of *I. pusilla.* The dominant species in this zone include *Morozovella acuta* (Toulmin) *M. aqua(Cushman and Renz), Globigerina linaperta* (Finlay) *Globorotalia haynesis* (Fayose) and *Acarinina primitiva* (Finlay). The *M. angulata* Zone occurs in Araromi – 1, Gbekebo – 1, Akinside (BH 1582) boreholes.(figs.3,5). The zone also occurs in borehole No 4925 Ewekoro and Shagamu limestone quarries.

***Globanomalina pseudomenardii* Zone**

P4 zone (Berggren *et al.,* 1995)

Age: Late Paleocene

Author: Bolli (1957)

The *Globanomalina pseudomenardii* Zone is a taxon range zone defined by the total range of its nominate species. The characteristic species include

Acarinina primitiva, Morozovella africana, M. costteina, Globigerina occlusa, Acarinina pseudotopilensis, M. angulata (white), *M. acuta* (Toulmin), M. *aqua(Cushman and Renz),*

M.Velascoensis(Cushman). The *G. pseudomenardii* Zone occurs in Araromi – 1 borehole(fig.2) and the Shagamu limestone quarry.

***Morozovella velascoensis* Zone**

P5 zone (Berggren *et al.,* 1995)

Age: Late Paleocene

Author: Bolli (1957)

This zone was defined as the partial range of the nominate taxon from the last appearance datum (LAD) of *Globanomalina pseudomenardii* (Bolli) to the LAD of *Morozovella velascoensis (Cushman).* The characteristic species include *Morozovella formosa, M. acuta, M. aequa, Acarinina primtiva.*The *Morozovella velascoensis z*one

occurs in Araromi-1 (fig.2) borehole and Shagamu limestone quarry.

Morozovella Subbotinae Zone

M. edgari zone (Toumarkine & Luterbacher, 1985)

Age: Earliest Eocene

Author: Berggren *et al.,* (1995)

The *M. subbotinae* zone is an interval zone that was defined between the LAD of *Morozovella velascoensis* (Cushman) to the FAD of *M. aragonensis(*Nutal). The Paleocene / Eocene boundary lies near type lower boundary of the *M. subbotinae* Zone which is placed at the LAD of *Morozovella .velascoensis* (Cushman). The characteristic species include *M. gracilis* (Bolli), *Globorotalia cerroazulensis(Cole)Acarinina soldadoensis* (Bronnimann), *A. primitiva* (Finlay),*Subbotina linaperta*(Finlay)

The *M. subbotinae* zone occurs in Araromi – 1 borehole.(fig.2). Although the nominate taxon *M. subbotinae* (Morozova) was not encountered in Akinside borehole (BH1582) and BH 4925 the presence of the following species *Acarinina pseudotopilensis A. pentacamerata (Subbotina), A.tribulosa (*Loeblich and Tappan*), Globorotalia wilcoxensis (*Cushman and Ponto*) and A. broedemani (*Cushman *and Bermudez),* suggest its presence (fig 4-5)

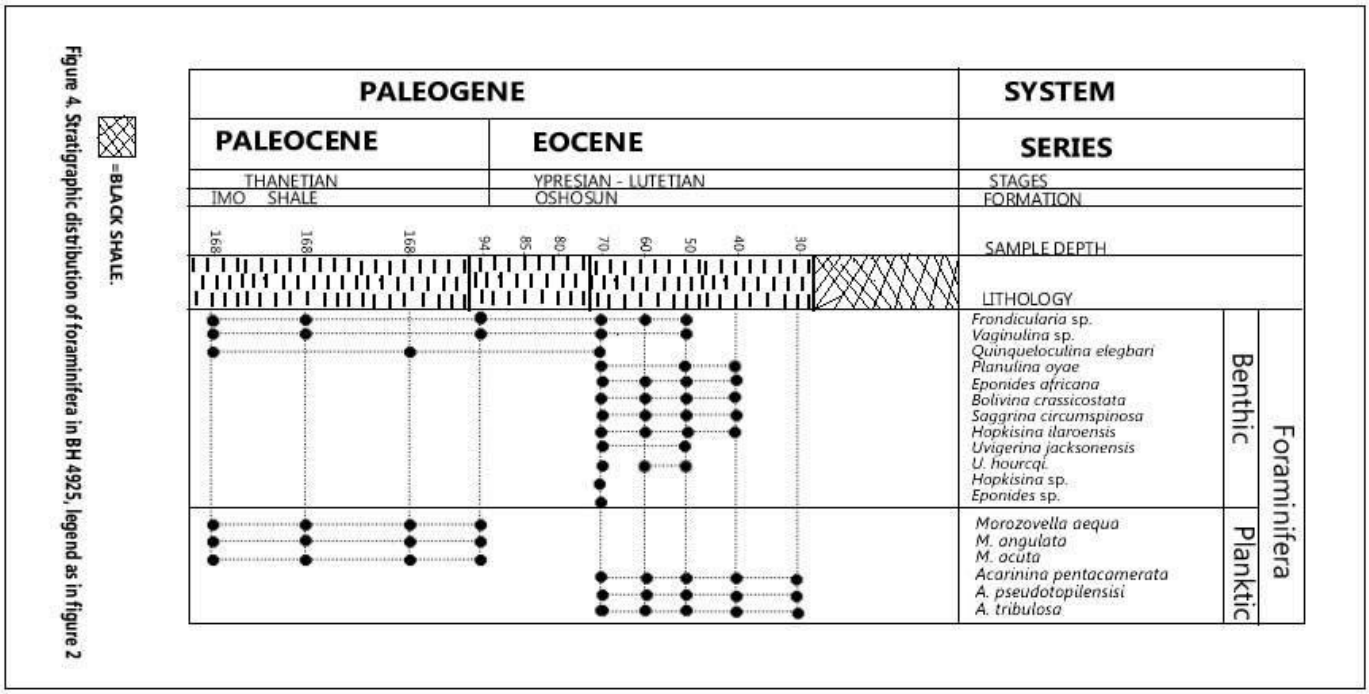


Figure 4. Stratigraphic distribution of foraminifera in BH 4925, legend as in figure 2

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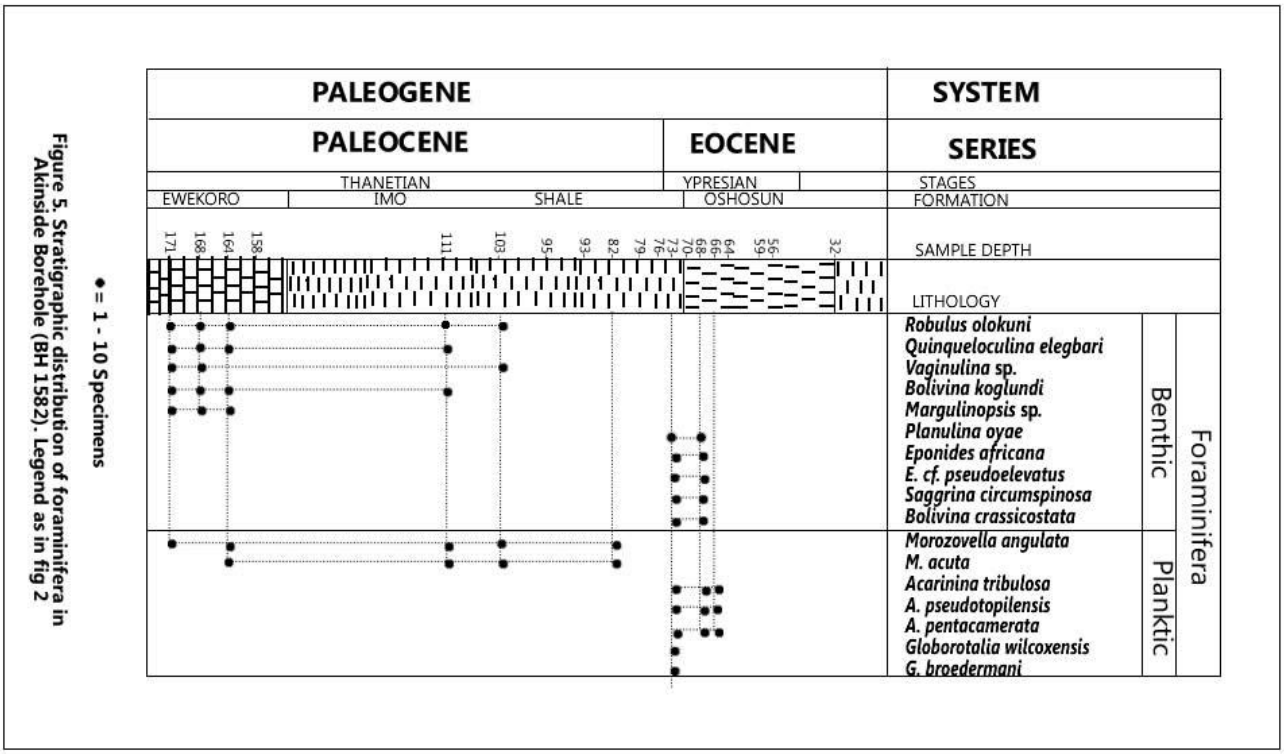

Figure 5. Stratigraphic distribution of foraminifera in Akinside Borehole (BH 1582). Legend as in fig 2

Benthic Foraminiferal Zones

The benthic foraminiferal species recovered in this study are long ranging. Two

concurrent range zones, one for the Paleocene and the second for the early Eocene have been identified. The concurrent-range-zones comprises of 2 overlapping species ranges which have time significance and possibilities of geographic extensions to several West and Central African basins. This is in consonance with the international stratigraphic guide (Hedberg, 1976).

Anomalinoides umboniferus – Anomalinoides midwayensis zone

Age: Early and late Paleocene

Author: Petters (1982)

This zone was defined by the concurrent range of the nominate taxa *Anomalinoides umboniferus* (Schwager) and *Anomalinoides midwayensis (Schages)*. The base of the zone coincides with the Cretaceous Tertiary boundary which is marked by the extinction of majority of the Maastrichtian species. The top is also defined by the disappearance of the typical Paleocene species and the nominate taxa (Petters, 1982). The zone embraces the Paleocene and includes the Imo shale (Fig. 2, 3) and Ewekoro Formation in the present study.

The characteristic species include: *Lenticulina midwayensis* (Plummer), *Gavelinella pachysuturalis* Chierici *(1996)* reported the presence of *Eponides Pseudoelevatus* Graham*, de Klasz and* Rerat from the Eocene of the Ivory coast and Ghana basins. The species was also found in the Eocene of Akinside Borehole (BH 1582) in this study. The occurrence of *Eponides Pseudoelevatus* in the Eocene invalidates its usage as a Paleocene index fossil*. Anomalinoides midwayensis (*Schwager*)* is hereby proposed as its replacement.

***Planulina oyae-Uvigerina hourcqi* Zone**

Age: Early Eocene

Author: Petters (1982)

The zone is defined by the overlapping ranges of the two nominate taxa *Planulina oyae* Reyment and *Uvigerina hourcqi (*Graham*,*de Klasz and Rerat). Base of the zone is marked by the abrupt appearance of the nominate taxa and other Eocene benthic

foraminiferal species and the presence of endemic West African Eocene species. The characteristic species include *Sagrina circumspinosa* (De Klasz & Rerat), *Eponides africana* De Klasz & Rerat, *Hopkinsina danvillensis* Howe & Wallace, *Uvigerina jacksonensis* Cushman. The disappearance of the above taxa characterises the top of the zone.

The zone embraces the Eocene but was found in this study in the Early Eocene. It occurs in the Oshosun Formation in all the wells of the present study.

DISCUSSION AND CONCLUSION

The Paleocene benthic foraminifera from the Eastern Dahomey basin recorded in this study shows strong affinity to the Midway type fauna of the Midway Formation of Gulf coastal plain of North America (Berggren and Aubert,1975). Some species of the assemblage are common to the Paleocene of Tunisia (Aubert and Berggren.1976), Libya and Mali (Berggren,1974) and Alabama (Mancini, 1984). The Paleocene benthic foraminifera from the Sokoto basin (Okosun,1999) shows no similarity to the assemblage recorded in the current study,this is in agreement with Petters(1979). Thus the two coeval assemblages belong to different biogeography provinces. This does not support the view of a union and faunal exchange between the Tethys and the South Atlantic ocean during the Paleocene.

The six planktic foraminiferal zones have be correlated to the interregional planktic foraminifera zones of Toumarkine and Luterbacher (1985) and Berggren et al (1995). Both the planktic and benthic zones will serve as useful correlation tools in the coastal and inland basins of West Africa

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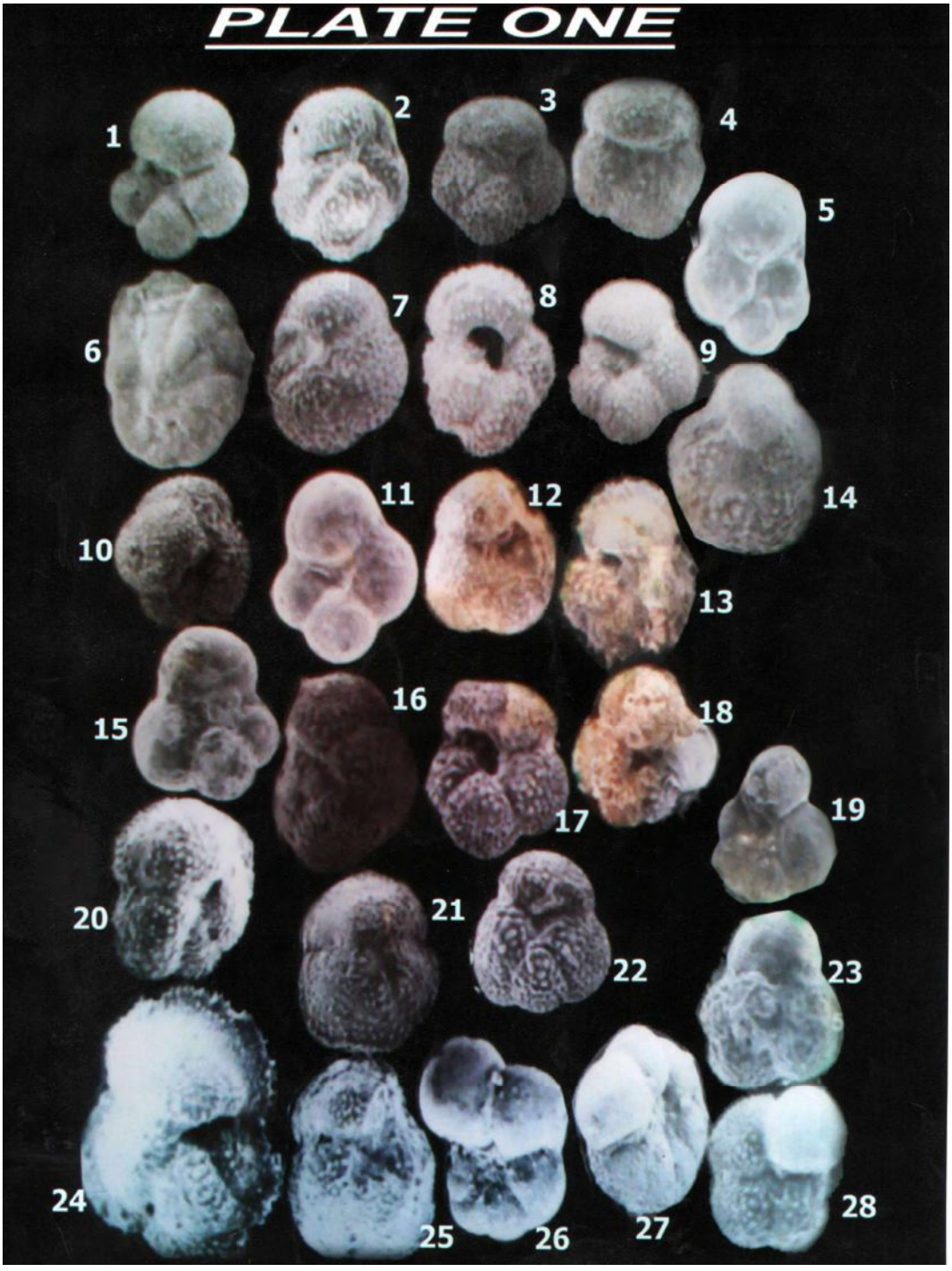


EXPLANATION OF PLATE ONE

Magnification x65

Fig.1*: Parasubbotina, pseudodulloides* (Plummer).

Fig.2, 4*: Acarinina, primitiva* (Finlay).

Fig. 3: *Globigerina, soldadoensis, angnlosa* (Bolli).

Fig. 5: *Globanomalina, compressa* (Plummer).

Fig. 6: *Globorotalia, haynesi, Fayose.*

Fig. 7, 17: *Globorotalia, cerraozulensis, pomeroli* (Tourmarkine & Bolli).

Fig. 8, 9, 18: *Acarinina, soldadoensis* (Bronniman).

Fig. 10, 12: *Praemurica uncinata* (Bolli)

Fig. 11, 16: *Parasubbotina, varianta* (Subbotina).

Fig. 13: *Morozovella, acutispira* (Bolli & Cita).

Fig. 14: *Morozovella, angulata* (White).

Fig. 19: *Praemurica, inconstans* (Bolli).

Fig. 20: *Acarinina, pentacamerata.*

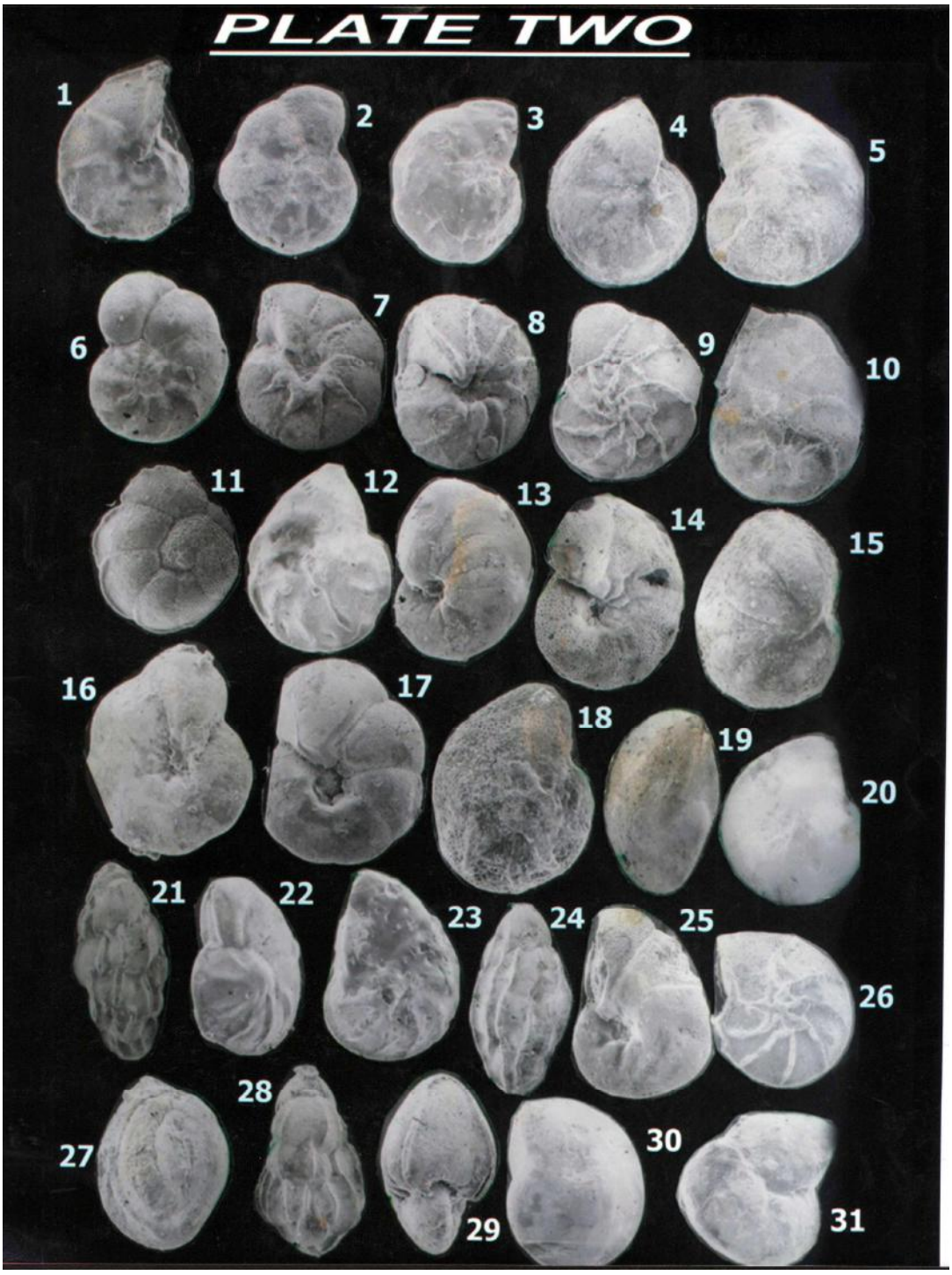
Fig. 21, 24: *Morozovella, aequa* (Cushman & Renz).

Fig. 23: *Globigerina sp*

Fig. 25: *M. angulata* (White).

Fig. 26: *Globigerinella, chipolensis.*

Fig. 27, 28: *Globorotalia, ngulisuturalis.*



EXPLANATION OF PLATE TWO

Magnification x60

Fig. 1: *Lenticulina sp1.*

Fig. 2-5: *Lenticulina, midwayensis* (Plummer).

Fig. 6: *Anomalinoides, midwayensis* (Plummer).

Fig. 7, 8, 18: *Eponides, pseuoelavatus.*

Fig. 9, 10, 26: *Eponides, pseuoelavatus.*

Fig. 11: *Gavelinlla sp* (Petters).

Fig. 12, 23: *Lenticulina, pseudomamilligerus* (Plummer).

Fig. 13, 29: *Nonion sp.*

Fig. 14: *Gavelinella, pachysuturalis* (Graham Et Al).

Fig. 15: *Nonionella, insecta* (Schwager).

Fig. 16: *Valvulineria sp.*

Fig. 17: *Anomalinoides, umboniferus* (Schwager).

Fig. 19, 20, 30: *Lenticulina, falto-limbatus* (Guembel).

Fig. 21: *Uvigerina sp1.*

Fig.22: *Lenticulina sp2.*

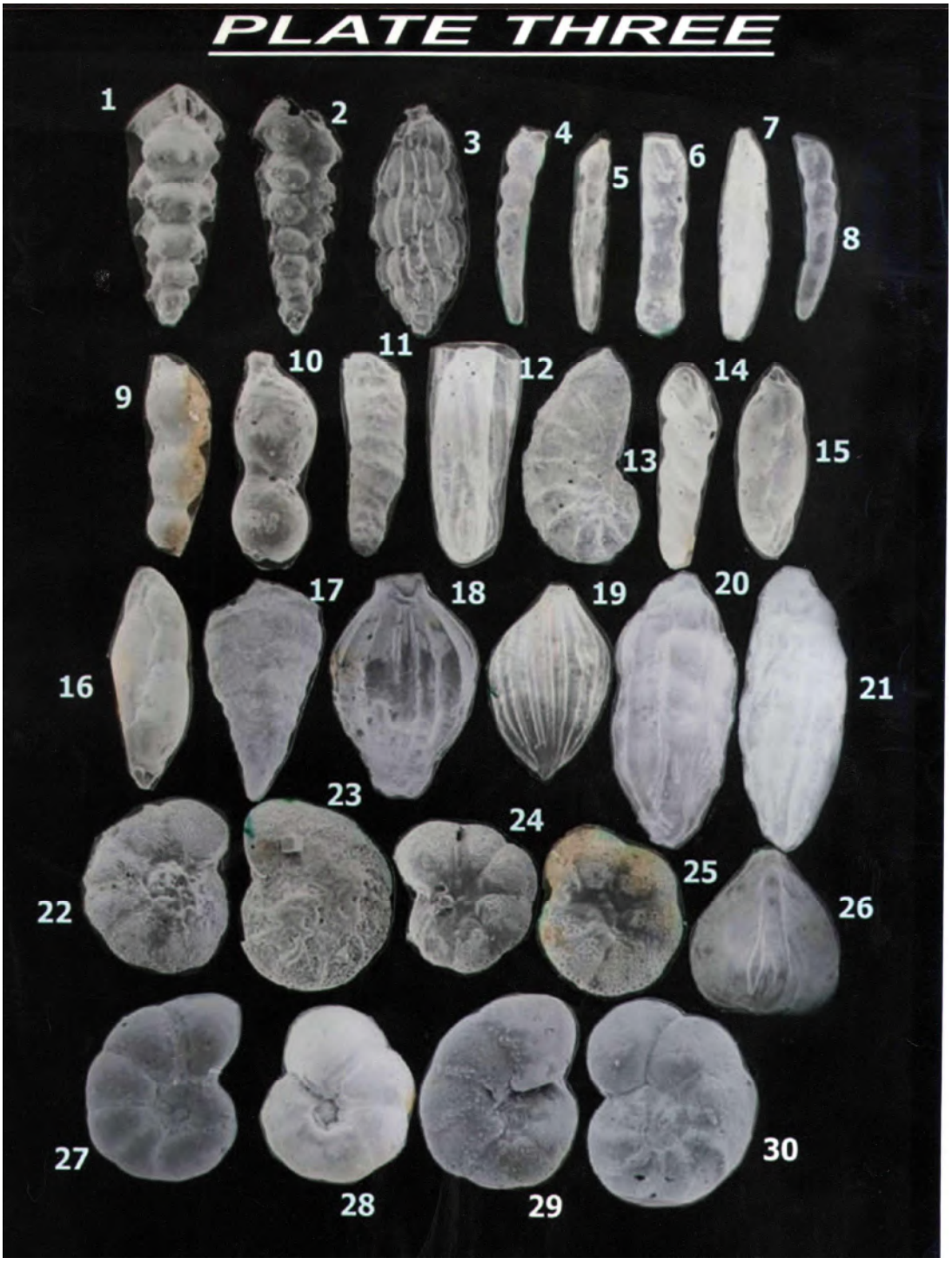
Fig. 24: *Uvigerina.*

Fig. 25:

Fig. 27: *Spirosigmolina oligocaenica* (Cushman).

Fig. 28: *Uvigerina sp.*

Fig. 31: *Lenticulina sp.*



EXPLANATION OF PLATE THREE

Magnification x60

Fig. 1, 2: *Sagrina, circumspinosa* (De Klaz & Rerat).

Fig. 3: *Hopkisina, ilaroensis* (Haynes & Nwabufo-ene).

Fig. 4, 8: *Dentalina, colei* (Cushman & Dusenbury).

Fig. 5, 7: *Dentalina, alternata.*

Fig. 9: *Dentalina* sp1.

Fig. 10: *Dentalina* sp2.

Fig. 11: *Virginulina.* sp

Fig. 13: *Lenticulina* sp.

Fig. 15, 16: *Furenkoina, elongata* (Petters & Adegoke).

Fig. 18: *Lagena* sp.

Fig. 19: *Pseudoglandulina* sp.

Fig. 20, 21: *Uvigerina, hourcqi* (Graham, De Klasz & Rerat).

Fig. 22, 23: *Gavelinella, guineana* (Petters & Adegoke).

Fig. 24, 25: *Anomalinoides* sp.

Fig. 26: *Frondicularia* sp

Fig. 27, 28: *Anomalinoides, midwayensis* (Plummer).

Fig. 29, 30: *Anomalinoides, umboniferus* (Schwager).