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STRATIGRAPHY AND PALEONTOLOGY OF THE EWEKORO FORMATION (PALEOCENE) OF SOUTHWESTERN NIGERIA

By

Oluwafeyisola S. Adegoke

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To Kunbi, Femi, Kunke, and Dayo
for their love

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CONTENTS

TEXT-FIGURES

TABLE

STRATIGRAPHY AND PALEONTOLOGY OF THE EWEKORO FORMATION (PALEOCENE) OF SOUTHWESTERN NIGERIA

Oluwafeyisola S. Adegoke[1]

ABSTRACT

The Ewekoro Formation at the type locality is composed of about 12.5 m of coquinoidal limestone. It is sandy at the base, grading into the underlying Abeokuta Formation and is overlain unconformably by phosphatic and glauconitic gray shales (Akinbo Formation) and a red sandy mudstone (the basal Oshosun Formation). It is well exposed in the Ewekoro Quarry about 55 km NW of Lagos, Nigeria.

The limestone is divisble into four microfacies units, a basal sandy biomicrosparite, overlain in turn by the shelly biomicrite, the algal biosparite and the red phosphatic biomicrite.

The Ewekoro macrofauna contains 221 species and subspecies, 175 of which are described as new. Three new families, nine new genera and thirteen new subgenera are also proposed. This diverse fauna is dominated by mollusks, among which nautiloids are common.

The fauna shows a marginal Tethyan affinity confirmed by the presence of *Nummulites ewekoroensis* Sachs and Adegoke, *Campanile nigeriense* Adegoke and Dessauvagie, and species of *Velates, Gisortia, ?Terebellum, Carolia, Crommium, Lithophaga,* and *Fimbria.*

The Ewekoro fauna lived under warm (subtropical) conditions at littoral to shallow sublittoral depths. The abundant ocurrence of unworn nautiloid shells, sparse planktonic Foraminifera, and shark and ray teeth indicate direct connection with the open sea. The absence of a true reef development indicates that a cold current comparable to the modern Benguela Current probably swept the West African coastline during the Paleocene.

The Ewekoro assemblage is dominated by microscopic forms less than 10 mm high. The unworn nature of the specimens and the absence of evidences of preferential sorting indicate that these are normal paedomorphic adults which had undergone selection for early maturity probably accompanied by high fecundity under a high-stress ecological condition.

Predation by naticids and muricids is common in the Ewekoro assemblage. No selectivity for valve, boring site or prey size was noticed. In contrast with extant forms, the Ewekoro naticids fed more frequently on gastropods.

The Ewekoro fauna is of Paleocene (Montian-Thanetian) age. This is confirmed by the associated ostracodes and planktonic Foraminifera. Paleocene index macrofossils such as *Togocyamus seefriedi* Oppenheim, *Clinuropsis diderrichi* Vincent and *Tornatellaea* (*Ravniella*) *africana* Furon occur abundantly. The fauna shares several species and identical or near-identical taxa with Paleocene horizons the world over. These include dated horizons in Senegal, Togo, Ghana and Congo, the Mokattam beds of Egypt, the upper Ranikot beds of India, the Midway Stage of the Gulf Coastal United States, the Soldado Rock in Trinidad and the Maria Farinha Beds of Pernambuco, Brazil.

Radiometric (K-Ar) dating of glauconites from two horizons which unconformably overlie the Ewekoro limestone yielded an age of 54.45 ± 2.7 m. y., a date closely corresponding with the Paleocene-Eocene boundary. This confirms an age not younger than Paleocene for the underlying Ewekoro Formation.

INTRODUCTION

Marine macrofossil-bearing strata of Paleocene age show a patchy distribution throughout the world. Some of the best known sections are the Danian beds at Faxe, Denmark (Ravn, 1933; Rosen-

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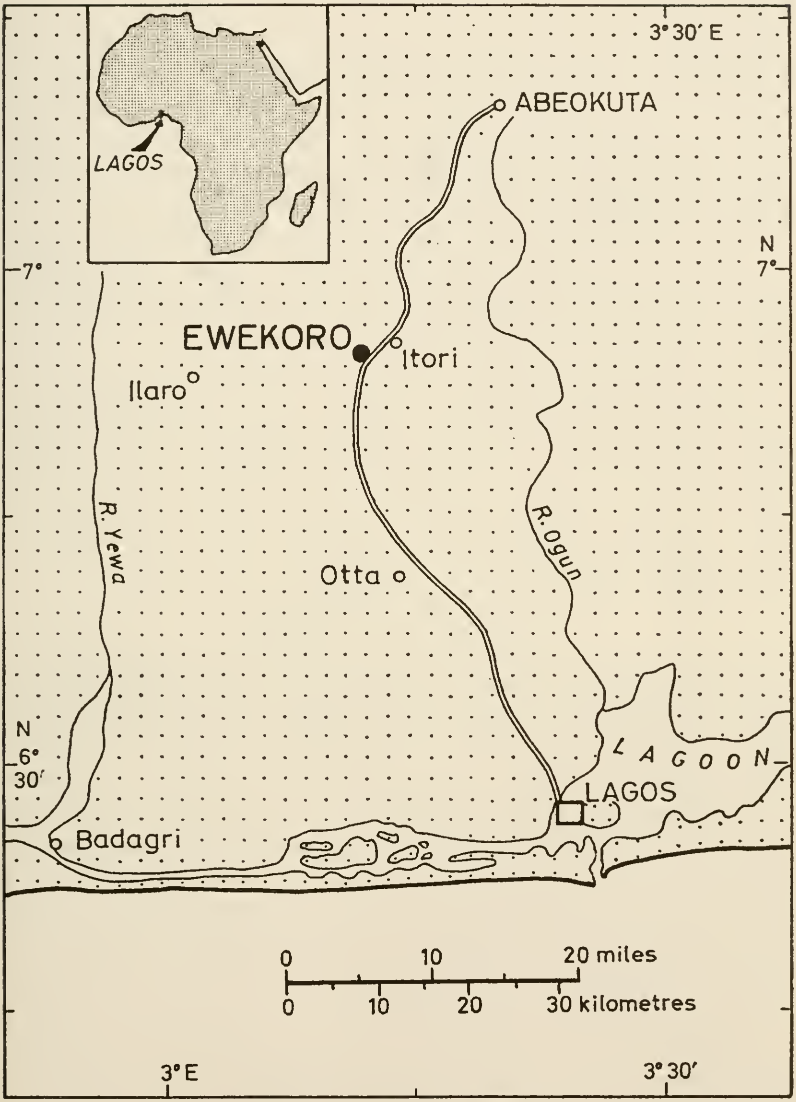
krantz, 1960), and at Copenhagen (Ravn, 1939; von Koenen, 1885); the Montian beds in Belgium (Briart and Cornet, 1871; Cossmann, 1908, 1913b, 1924; Vincent, 1930b); the Thanetian beds of the Paris Basin (Farchad, 1936) and England (Prestwich, 1852; Morris, 1852; Edwards and Wood, 1848-1877); the upper Ranikot beds of India (Cossmann and Pissarro, 1909, 1927; Douvillé, 1928, 1929; Cox, 1930; Vredenburg, 1929); the lower Mokattam beds of Egypt (Oppenheim, 1903, 1906); the Midway Stage of the American Gulf Coastal Plain and Texas (Harris, 1896; Gardner, 1933); the Kangilia and Agatdal formations of West Greenland (Rosenkrantz, 1970) and the Soldado Rock of Trinidad (Rutsch, 1943).

In West Africa, marine macro-invertebrate bearing Paleocene strata have been reported from a number of scattered localities (Furon, 1949; Chavan, 1949). The best known are the Landana beds of Congo (Vincent, 1913; Miller, 1935, 1951); various localities in Senegal (Tessier, 1949, 1952; Chabaglian, 1959), in Morocco (Salvan, 1954) and in Soudan-Niger region (Furon, 1935, 1949; Douvillé, 1920), the Adabion and Togblékové beds in Togo (Oppenheim, 1915; Furon 1948) and the Apatuema Limestone in Ghana (Cox, 1952). Larger invertebrates are yet to be described from the Paleocene cliffs at Fresco, Ivory Coast (Lys, 1961).

In Nigeria, marine macrofossil-bearing strata of Paleocene age are known in the Kalambaina Formation of the Sokoto area (Parker, 1964) and in the Ewekoro Formation in the west (Jones and Hockey, 1964; Reyment, 1965a, Adegoke and others, Colloquium 1971, Proc. Colloquium 1970). This latter formation, which is well exposed in the quarry of the West African Portland Cement Company Limited at Ewekoro (Text-fig. 1) is the object of this study.

Detailed study of the Ewekoro quarry section was commenced by the writer in 1967 with the primary aim of establishing the stratigraphy, describing the fauna, and elucidating the affinities of the latter.

Fossils were collected from different parts of the quarry between 1967 and 1970. This fauna, containing about 220 species was identified and analysed in 1970 and 1971 at the Smithsonian Institution, Washington, D.C., using the facilities of the National Museum of Natural History. The material was carefully compared



1. Map showing the location of Ewekoro, Nigeria

with the faunas of classical European, Middle East, and American Paleocene localities.

The study is significant in that it greatly increases the knowledge of the marine Paleocene fauna of West Africa. The faunal similarities between now-distant areas confirm the importance of the role played by the trans-saharan epeiric sea and the Tethys in the zoogeographic distribution of marine faunas during the Paleogene. The bearing of these on the problem of Continental Drift is briefly discussed under Regional Geology and Paleogeography.

The study further shows that the Paleocene faunas of West Africa are evolutionarily distinct from the Eocene faunas of the same area, thereby strengthening the case for the distinctness of the Paleocene Epoch.

This study has one major limitation. It was not possible to collect stratigraphically controlled samples. This is a factor imposed by the highly indurated matrix (see Petrography and Microfacies). As a result, the precise stratigraphic ranges of the described fossils are not known. No attempt is, therefore, made at a refined biostratigraphic zonation or correlation in this study.

ACKNOWLEDGMENTS

The writer is indebted to the Smithsonian Research Foundation for its award of a Postdoctoral Visiting Research Associateship which enabled him to work at the Smithsonian Institution during the academic year 1970-71 when most of this work was completed.

Several colleagues and friends at the Smithsonian Institution and the U.S. Geological Survey, Washington, D.C., facilitated my stay. In particular, I gratefully acknowledge the help of Porter M. Kier with the echinoids and J. P. E. Morrison with the vermetids. W. P. Woodring, N. F. Sohl, T. R. Waller, Erle G. Kauffman, and Druid Wilson gave much of their time in the identification of the mollusks. They also read much of the manuscript. Dr. T. R. Waller in addition gave the writer free access to his photographic facilities. Fred Collier, Don Dean, Jessie Merida, Tom Phelan, and Robert Matthews gave much technical help. R. Cifelli, R. K. S. Evernden, M. Buzas, R. Boardman, J. Pojeta, M. E. Taylor, and S. O. Schweitzer helped in many ways.

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Finally the writer thanks his wife, Adekunbi Adegoke for her constant help and encouragement.

HISTORY OF PREVIOUS GEOLOGICAL WORK IN THE REGION

Though the Cretaceous and Tertiary strata of Western Nigeria have been studied by a number of workers since Parkinson's (1907) pioneer work (for example, Wilson, 1922; Russ, 1924; Tattam, 1944; Geol. Sur. Nigeria, Lex. Strat. Intern., 1956; Reyment, 1960), the identity of the Ewekoro Formation was not recognized until recently. Virtually nothing was known of the fauna until the initiation of the present series of studies by the writer in 1967. This oversight was due primarily to the heavy soil and vegetation cover and the lack of exposures. Awareness of the occurrence of the formation in Nigeria was gained largely from Togo, where outcrops were seen in the Mono Valley. Water wells drilled in the vicinity of Adabion as early as 1910 also penetrated limestone at depths varying between 13 and 30 meters (Stromer von Reichenbach, 1910).

The first detailed study in Nigeria was by the Associated Portland Cement Manufacturers Limited during the search for raw materials for a cement factory. The results of their investigation were issued as six unpublished reports the last of which contained a synopsis of the geology of the area.

The Ewekoro Formation was first described in detail and formally named by Jones (*in* Jones and Hockey, 1964). He selected Ewekoro as the type locality and described as type section a composite section, 483 feet thick, compiled from Geological Survey of Nigeria boreholes 1582 and 1583 at Akinsinde, a village about 10 miles SSW of Ewekoro. Jones' system of erecting a type section based on two different wells which are, in addition, geographically removed from the designated type locality contravenes conventional stratigraphic practice (American Code of Stratigraphic Nomenclature, 1961) and was criticized by the writer (Adegoke, 1969b; Adegoke, and others, 1971, Proc. Colloquium 1970).

The Ewekoro Formation as used by Jones also included the overlying shale which has since been referred to a different formation by all other subsequent workers except Antolini (1968) and Fayose and Asseez (1972). Jones mentioned the abundant occurrence of the echinoid *Togocyamus seefriedi* Oppenheim at Ewekoro and listed 11 Foraminifera and 24 ostracodes identified from the quarry in an unpublished report by Reyment in 1963. He suggested a lower Paleocene age for the formation.

In a work published almost simultaneously with Jones' study Reyment (1964) used the name Ewekoro Formation. He restricted the unit to the limestone only and chose as type, the section exposed in the quarry at Ewekoro. He suggested an upper Paleocene age for the formation.

In a brief paper describing the 1965 excursion of the second West African Micropaleontological Colloquium to the Ewekoro area, Reyment (1966a) described a number of ostracodes and Foraminifera from the Paleocene of Western Nigeria based mostly on borehole material. It included about four species from the Ewekoro quarry. In a footnote at the end of the paper, he recorded a discovery of the nautiloid, *Deltoidonautilus togoensis* (Oppenheim) from the quarry.

Some Paleocene nautiloids from various parts of Nigeria were discussed in a short paper by Reyment (1966d). It included a specimen referred by him to *Cimomia landanensis* Vincent from the Ewekoro quarry.

In a paper reviewing the Eocene succession of southern Nigeria, the writer (Adegoke, 1969b) discussed the relationship of the Ewekoro Formation with the superjacent and subjacent strata. He discussed the Cretaceous-Paleogene paleogeography of the area and accepted Reyment's restriction of the formation to the limestone only.

Adegoke and Dessauvagie (1970) described *Campanile nigeriense* from the quarry. Considering that the only other West African record of the mollusk, is in the Paleocene of Senegal, they suggested that the genus may be an index to the Paleocene in West Africa.

Adegoke and others (1971, Proc. Colloquium 1970) described in considerable detail the stratigraphy of the Ewekoro Formation and subdivided it into three microfacies units, the sandy biomicrosparite at the base overlain in turn by the shelly biomicrite and the algal biosparite. They accepted the Paleocene age assigned earlier by Jones and Reyment.

Ogbe (1970, 1972) studied the micropaleontology of strata exposed in the Ewekoro quarry. He recorded a diverse foraminiferal fauna containing over 40 species from the limestone and erected a fourth microfacies unit, the red phosphatic biomicrite, above the algal biosparite. He cited several stratigraphic and lithologic evidences in support of separation of the limestone from the overlying shale showing that the latter differed markedly from the Imo Formation of Eastern Nigeria. He, therefore, proposed the new name Akinbo Formation for the shales in inland Western Nigeria. On the basis of planktonic foraminiferal evidence, he assigned a lower to upper Paleocene age (uppermost Danian to Thanetian-Landenian Stages) to the Ewekoro Formation.

In a series of abstracts read at meetings and a major paper, Fayose and Asseez (1972) announced the results of their study of the Akisinde borehole located about 10 miles southwest of Ewekoro. They argued for the inclusion of both the Ewekoro limestone and the overlying shale as members of the Imo Formation and assigned an Eocene age to the entire sequence.

Adegoke (1972a, 1972b, 1973) in a series of short papers, highlighted the results of his continuing investigation of the macrofauna of the Ewekoro area. He recorded the discovery of a fauna containing about 220 species of macro-organisms in the quarry. He stressed the Tethyan affinities of the Ewekoro and West African

Paleogene faunas, based on the presence of *Nummulites* and a number of typical Tethyan mollusks (*e.g. Campanile, Gisortia, Velates*) in the area. On the basis of the evolutionary stage of the fauna and the occurrence of several index forms, he assigned the Ewekoro fauna to the Montian-Thanetian Stages of the Paleocene.

Some algae from the Ewekoro Formation were discussed by Kogbe (1972b), who concluded that they represented Paleocene forms.

Results of a radiometric age determination (K-Ar) of glauconites from two horizons in strata disconformably overlying the Ewekoro Formation (Text-fig. 6) were presented by Adegoke and others (1972). These yielded an average age of 54.45 $\pm$ 2.7 million years, an age corresponding to the Paleocene-Eocene transition (Berggren, 1969, 1972).

Finally, in a recent paper Sachs and Adegoke (1973) described *Nummulites ewekoroensis* from the Ewekoro Formation.

Study of fossiliferous Paleocene strata began much earlier in neighboring West African countries. These were reviewed in detail by Cox (1952, pp. 29-32), and only the major works relevant to Nigeria are mentioned below.

The earliest authoritative study of Paleocene macrofossils from West Africa was by Vincent, who in 1913 described a fauna of about 40 species from Landana, Congo. He recorded *Clinuropsis diderrichi* Vincent, a ubiquitous species which has subsequently been recorded in Paleocene strata in Nigeria, Togo, Ghana, Senegal, and the Soldado Rock of Trinidad (Rutsch, 1943). The species is now universally considered a Paleocene index species.

Oppenheim, in a beautifully illustrated monograph, described a fauna containing 32 taxa from the Adabion area, Togo, in 1915. The fauna included the minute echinoid, *Togocyamus seefriedi* Oppenheim, now considered a Paleocene index form (Durham, 1966). He stressed the contemporaneity of the Togo fauna (which he referred to the lower Eocene) with the fauna of the Upper Ranikot of India and the so-called "Libyan Stage" of Egypt.

The Paleogene fauna of Soudan and Senegal was discussed in a important paper by Douvillé (1920). It included the first record of *Gisortia* in West Africa.

Furon (1948) described a fauna of about 67 species, mostly new, derived from a water borehole at Togblékové, Togo. His descriptions were sketchy and most of his illustrations were poor (for example, *Tellina (Elliptotellina) Kouriatchyi* Furon, p. 98; *Acera togoensis* Furon, pl. 9, fig. 21; and *Bullinella (Cylichnina) togoensis* Furon, pl. 9, fig. 22).

In two papers, Miller (1935, 1951) described several nautiloids from the Paleogene of West Africa. He referred most of the species to the genus *Cimomia* and emphasized the difficulty of using these planktonic forms for regional correlation.

Cox (1952) described a fauna of 27 species, 20 of which were new, from a limestone penetrated by a well at Apatuema, Ghana. He correlated the beds with the limestone beds of Togo and Popenguine, Senegal.

Tessier (1952) and Chabaglian (1959) described a few Paleocene macrofossils from various localities in Senegal.

GEOGRAPHY

The Ewekoro Formation occupies a low-lying, marshy depression, the Ewekoro depression, bounded to the north and south by highlands (Jones and Hockey, 1964, fig. 2). This feature, oriented approximately east-west, is an eastward continuation of the Lama depression recognized earlier in Togo and Dahomey (Slansky, 1958, 1962). The depression has an average elevation of 100 feet above sea level and is widest near the Nigeria-Dahomey border where it is almost 8 miles wide. It narrows progressively eastward, finally disappearing beyond Ijebu-Ode (Jones and Hockey, 1964, *loc. cit.*).

The Ewekoro depression is bounded on the north by the northern uplands, a plateau-like feature rising to a maximum height of about 700 feet. The southern uplands rise gradually from the southern limit of the depression to a height of about 400 feet near Ilaro, thereafter dropping progressively to the low-lying coastal strip, the marginal barrier island and lagoon complex of Allen (1965).

The Ewekoro area is poorly drained. This is due to the combined effect of the low relief, high groundwater table, and the impervious nature of the underlying bedrock. There is a network of creeks and the drainage is deeply incised (Pl. 2, fig. 2). Ewekoro River is the dominant river into which many ephemeral tributaries drain during the rainy months. Much of the area is water-logged for much of the year and quarrying is partly done below the water table. A permanent lake into which all the major streams were diverted was created in the middle of the quarry area (Pl. 1, fig. 1). This lake supplies most of the water used in the works.

Ewekoro is situated in the subequatorial belt. It characteristically has heavy rainfall between April and September and a dry season between October and March. Vegetation is of the "high forest" type in which plantations of kola-nut, cacao, and oil palm predominate. Intense farming and deforestation have altered the vegetation, especially near settlements.

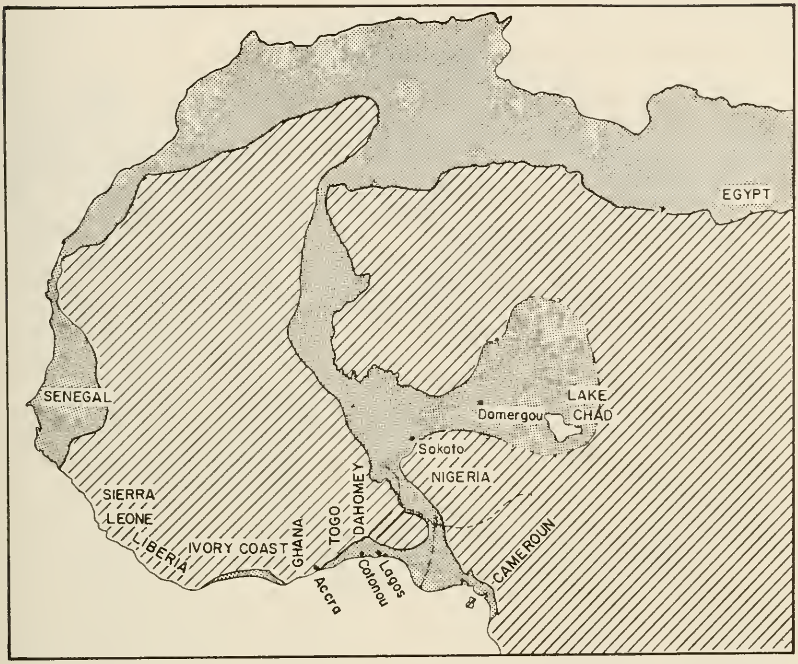
The West African Portland Cement Company Limited, in partnership with the Associated Portland Cement Manufacturers Limited of the United Kingdom and the United Africa Company of Nigeria, went into production on December 3, 1960 with an initial annual capacity of 200,000 tons of cement per year. The facilities were progressively expanded to the 500,000 ton a year mark. With the recent (1973) commissioning of a third kiln, the output will increase to 840,000 tons annually.

REGIONAL GEOLOGY AND PALEOGEOGRAPHY

The Southern Nigerian Tertiary sediments accumulated in the eastern half of an extensive Mesozoic-Cenozoic Coastal Basin (the Southern Nigerian Basin of Frankl and Cordry, 1967; and the Nigerian Coastal Plain Geosyncline of Allen, 1964, 1965), which extended from the Ghana region in the west to the Cameroun Republic in the east.

Since its inception during the Mesozoic, locally derived sediments have accumulated almost continuously in the basin. These deposits vary markedly in texture and in thickness from place to place, attaining a maximum of about 35,000 to 40,000 feet beneath the shelf off the Niger Delta (Allen, 1964, 1965; Stoneley, 1966; Short and Stauble, 1967; Frankl and Cordry, 1967).

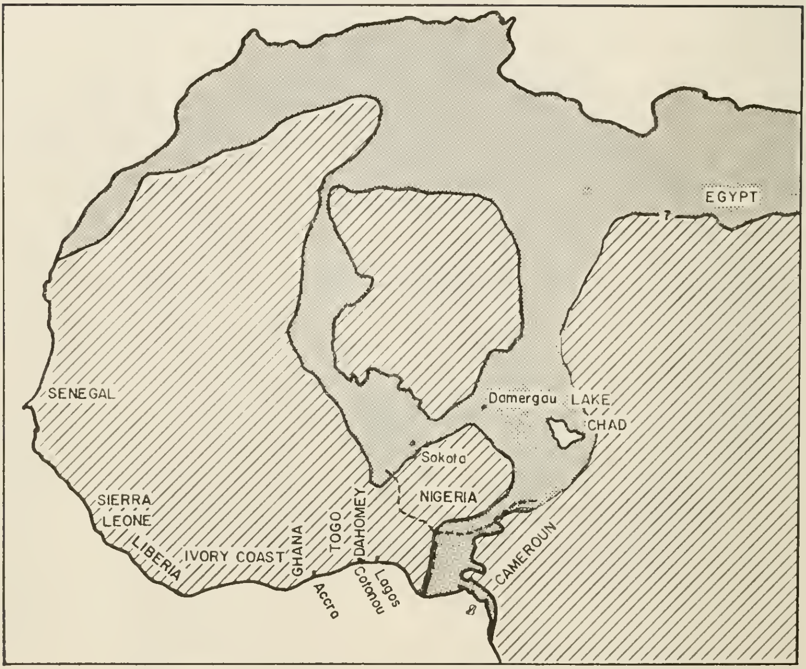
Available stratigraphic evidence suggests that subsidence accompanied by normal marine transgression began in West Africa during the Albian (Fail and others, 1970; Grant, 1971; Ramsay, 1971; Reyment, 1965a, 1966b). Deposition was at first confined to the eastern half of the basin (Text-fig. 2) but extended to all the other parts during the Maestrichtian (Text-fig. 3).



2. Generalized map showing the Albian-Turonian transgression in western and northern Africa

Three depositional cycles have been recognized (Short and Stauble, 1967; Frankl and Cordry, 1967; Murat, 1972; Weber, 1971). The first ranged from mid-Albian to Cenomanian. The second began with a transgression during the Turonian culminating in the Santonian folding phase. The final cycle began with a major and extensive transgression during the Campanian-Maestrichtian followed later by a regressive phase which has continued with minor interruptions to the present. Major oscillations are known especially those connected with the world-wide eustatic changes in sea level during the glacial period (Maron, 1969).

The Albian-Cenomanian cycle led to the deposition in the eastern part of Nigeria of a sequence of shales and limestone, referred to the Asu River Group (Reyment, 1965a) and the lower Odukpani Formation (Dessauvagie, 1972). The Uomba Formation and the Arufu Limestone of Northern Nigeria can be correlated with lower part of the sequence (Reyment, 1965a).



3. Map showing the probable maximum extent of the Campano-Maestrichtian transgression

The Turonian sea extended up the Benue Valley and in it were deposited thick sequences of montmorillonitic marine shales with limestones at the base. Transitional and continental sandstones characterize the regressive phases (Burke and others, 1972). This sea apparently had direct connections with the Saharan area where a southward extension of the Tethys had formed an embayment in the vicinity of Hoggar and Sokoto as early as the Cenomanian (Furon, 1963, p. 50; Reyre, 1966, fig. 7). This embayment has been variously termed the Sokoto Embayment (Reyment, 1965a, fig. 9) or the Iullemmeden basin (Greigert, 1965; Monciardini, 1966). Ammonites from Damergou in the Iullemmeden Basin share several species in common with those from Pindiga in the Benue Valley (Woods, *in* Falconer, 1911; Barber, 1957; Carter and others, 1963; T. F. J. Dessauvagie, oral communication).

The Senonian transgression was interrupted by a folding phase which began in Coniacian time and culminated during the Santonian (Carter and others, 1963; Cratchley and Jones, 1965; Short and Stauble, 1967, p. 774; Murat, 1972). As a result, the Benue trough sediments were folded into long gentle anticlines and synclines (Carter and others, 1963). The folding also affected the sedimentary sequences to the south, leading to the formation of structures such as the Abakaliki anticlinorium and the Afikpo syncline (Short and Stauble, 1967, fig. 7) in eastern Nigeria. Over 1,000 m of volcanic rocks were erupted in this region. This is the only folding phase that has affected the African continent since the Paleozoic. Though no evidence of this tectonism can be found west of the Niger, as a result of it, new depocenters were established on both sides thus setting the stage for the Campanian-Maestrichtian transgression.

Sediments deposited during this cycle include the Eze-Aku Group and the Awgu Group of eastern Nigeria. In the Benue Valley near Bambam and northwest on the Zambuk Ridge, pre-Turonian continental sandstones of the Bima Formation give way to the transitional Yolde Formation which is overlain by a sequence of marine limestones and shales referred to the Pindiga Formation. Near Bambam, the lower limestone is called the Dukul Formation and the overlying shale the Jessu Formation (Carter and others, 1963). They are succeeded by continental strata.

The major crustal subsidence which accompanied the Santonian folding phase led to another widespread marine transgression during the Campano-Maestrichtian. This transgression was restricted not only to the eastern portion of the basin which had been the site of deposition since the Albian, but extended to Western Nigeria, west of the Okitipupa Ridge (Adegoke, 1969b), the Niger Valley (Adeleye and Dessauvagie, 1972) and the other West African coastal basins (Text-fig. 3 and Adegoke, 1969b, fig. 1).

Fossiliferous marine rocks of Maestrichtian age occurred simultaneously in all these basins (Spengler and others, 1966; Spengler and Delteil, 1966; Tessier, 1952; Slansky, 1962; Reyment, 1965a), and in most of the countries (*e.g.* Togo, Dahomey, Nigeria, Senegal, Cameroons) marine Upper Cretaceous rests either directly on the Precambrian Basement Complex non-conformably, or on continental deposits locally derived from weathered basement rocks (*e.g.* Shasha

River area, Western Nigeria). These continental strata constituting the "Continental Inter-calaire" of the francophone countries (Slansky, 1962; Furon, 1935, 1963; Greigert, 1965) have rarely been studied in detail or named in the anglophone countries. In some boreholes along coastal Nigeria, they attain a thickness of over 1,000 m (unpublished information).

The middle to upper Albian and the Turonian-Coniacian transgressions shown for Western Nigeria and adjacent countries by Reyre (1966, figs. 6, 8) are, therefore, probably erroneous.

The deposits of the Campano-Maestrichtian transgression in Eastern Nigeria include the upper part of the Nkporo Shale, the Mamu, Ajali, and Nsukka Formations (Reyment, 1965a; Short and Stauble, 1967, fig. 1). In Western Nigeria, the Maestrichtian strata are assigned to the Abeokuta Formation, a predominantly sandy unit outcropping south of Abeokuta in the vicinity of the study area.

The Maestrichtian transgression covered not only the coastal areas but extended far inland, especially in Nigeria where a northern arm extended up the Niger Valley and linked up with the Sokoto Embayment. The extent of this transgression which continued into the Paleocene is shown in Text-figure 3.

Maestrichtian fossiliferous marine strata have been recorded as far north as Damagum area in the Chad Basin (report by various oil companies; Carter and others, 1963; also Burke and others, 1971). These were probably deposited in an eastern extension of the Iullemmeden embayment. The fact that outcrops are unknown in that area may be due to complete removal by erosion, a feature that is not uncommon in the geological history of the African landmass (also Murat, 1972).

Much attention has been focussed on the Cretaceous-Paleogene paleogeography of Saharan Africa since A. de Lapparent (1903) first suggested the possibilities of a trans-saharan marine connection between the Sokoto region and Egypt. The subject was rendered more interesting by the greater faunal similarity observed between West Africa and India (Hangu shales and upper Ranikot beds) and the dissimilarity of both faunas with those of neighboring European areas (Oppenheim, 1915; Cox, 1930). On account of this affinity, Douvillé (1920) talked of an "Indo-African" faunal province.

Ideas about the nature of the trans-Saharan connection had varied widely. Gregory (1929) thought that a gulf stretched due south from the Mediterranean across the central Sahara. Cox (1930, p. 41), while accepting the faunal affinity could not conceive the paleogeographic setting under which such affinity could have developed. He suggested, instead, that communication was established via the Mediterranean and a sea to the west of Africa such as the modern Atlantic. Trans-Saharan routes that shifted from east to west with time were suggested by Greigert (1965) and Reyre (1966). A permanent connection via the Benue Valley was supported by Furon (1935, 1963), Reyment (1965a), Kennedy (1965), and Reyre (1966, figs. 9, 10).

Because of the absence of post-Turonian marine strata in the Benue Valley around Bambam and the widespread occurrence in the northern area of the continental Kerri-Kerri Formation (Carter and others, 1963; Geol. Sur. Nigeria, 1964), the writer suggested (Adegoke, 1969b, p. 26) that the Campano-Maestrichtian transgression could only have passed through the Niger Valley. Subsequent study of the area by Dr. D. Adeleye of the University of Ibadan, Nigeria (Adeleye and Dessauvagie, 1972) has confirmed the presence of several marine horizons in the Nupe and Lokoja sandstones of the Niger Valley.

Some controversy still exists with regard to the exact route of the trans-Saharan sea especially because of the absence of evidences of a marine connection between the Sirte Basin in Libya with the south during the Upper Cretaceous (Barr, 1972; Klitszch, 1972, oral communication). It appears most likely that the connection was established *via* southern Algeria (Text-fig. 3).

The Maestrichtian transgression continued into the Paleocene. The Paleocene sea covered the entire southern Nigeria extending westward to Dahomey and Togo. Marine deposits with identical faunas are also known from Ghana (the Apatuema Limestone, Cox, 1952) and at the cliffs of Fresco in Ivory Coast (Lys, 1961). Farther north in the Sokoto area, fossiliferous shallow-water limestones (the Kalambaina Formation, Parker, 1964) were deposited overlain by calcareous shale.

A submarine basement ridge, the Okitipupa ridge (Adegoke, 1969b, fig. 5) partially separated the western Nigeria sub-basin from the Niger Delta basin to the east. This ridge continues on land as a ridge of basement complex rocks whose outcrop approaches within 25 miles of the coast at about 4° 30′E (Jones, 1964, p. 57). Marked thinning of strata occurs over the ridge, and the depositional history and lithology differ significantly on either side of the structure from the first Albian transgression to about Oligo-Miocene times when coarse, predominantly continental sands (Ogwashi-Asaba and Benin Formations) were deposited uniformly over the area (Text-fig. 5).

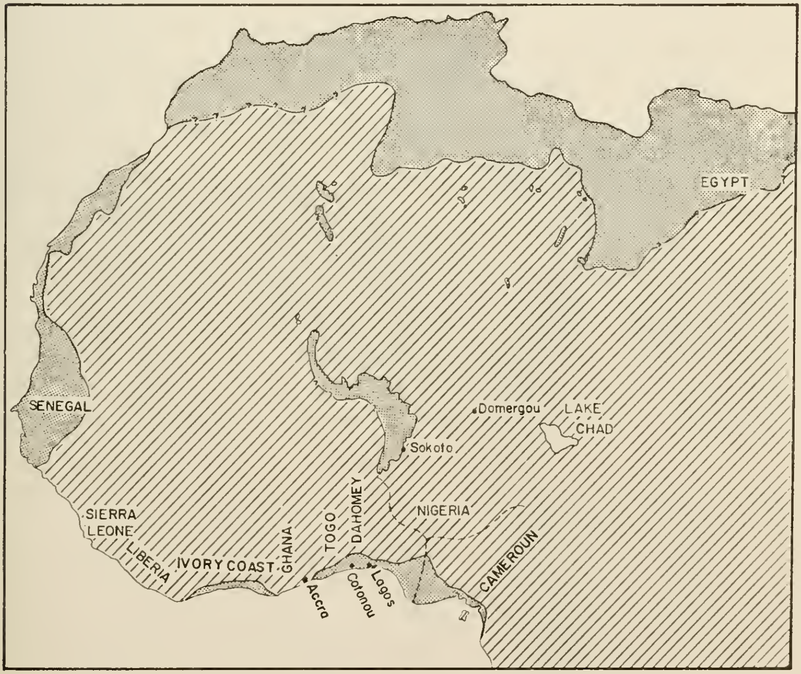
The Paleocene deposits are characterized by extremely rapid lateral facies change. The strata to the east and west of the Okitipupa ridge were also different. In eastern Nigeria, the strata are largely composed of the dark gray, thinly laminated friable Imo Shale with occasional admixture of clay ironstone and thin sandstone bands (Wilson, 1925; Adegoke, 1969b). Three arenaceous lateral equivalents, the Igbabu, Ebenebe, and Umuna sandstones have been recognized (Reyment, 1965a; p. 89) within it.

To the west, the depositional environment was more diverse, producing a greater variation in lithofacies. Nearshore, in western Nigeria, biogenic limestones of the Ewekoro Formation are found in the lower part of the Paleocene section (Jones and Hockey, 1964; Adegoke, 1969b; Adegoke and others, 1971, Proc. Colloquium 1970). It is overlain disconformably by the Akinbo Shale. In other areas especially to the south, the sequence is largely shale with thin limestone intercalations near the base (*e.g.* wells Benin-1, Ore-1 and Benin West-1 on the Benin Flank, Murat, 1972). In Dahomey and Togo, the sequence begins with a variably thick limestone, the Calcaire à *Togocyamus*, overlain by marls and calcareous shales, the Argile à attapulgite (Slansky, 1962).

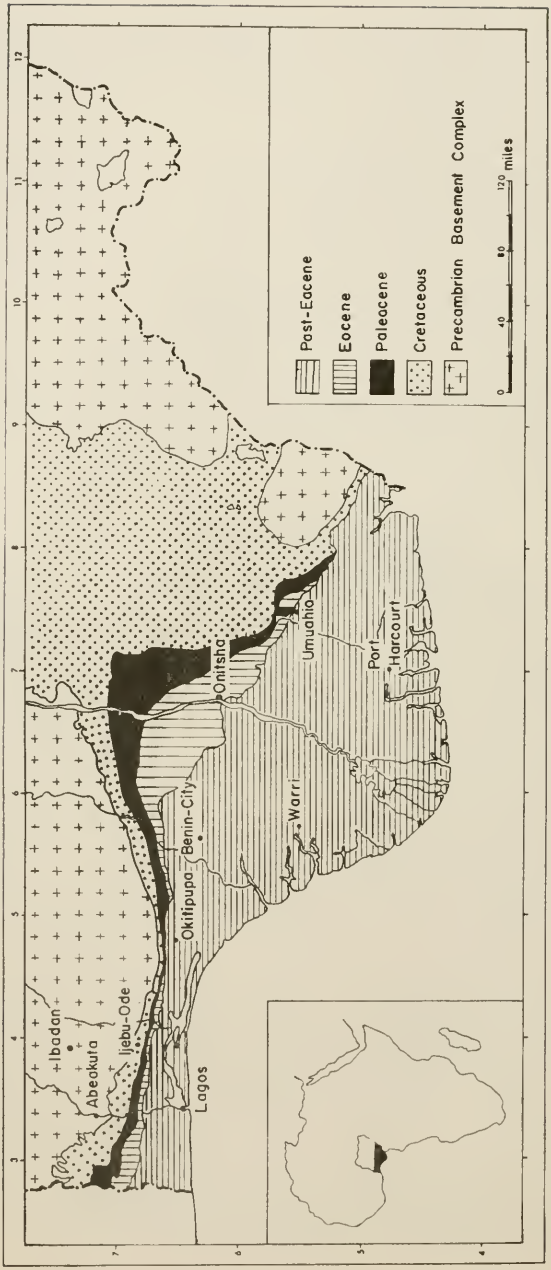
The deposition of the Ewekoro Formation was followed in Western Nigeria by minor, probably local crustal elevation which resulted in the intensive erosion and potholing of the upper units (the algal biosparite and red phosphatic biomicrite) of the limestones (Pl. 3, fig. 1). The lateral extent of this disconformity has not been established. Fossiliferous glauconitic shales and phosphates accumulated on the erosional surface as the area subsided, once again, towards the end of the Paleocene. The overlying Akinbo Shale is thickly laminated and poor in planktonic Foraminifera. Using the modern planktonic foraminiferal bathymetric zones proposed by us for the adjoining Gulf of Guinea Shelf and upper Continental Slope (Adegoke and others, 1971), the depositional environment was probably not more than 25 meters deep.

Simultaneously, a sequence of limestones and calcareous shales, the Dange Formation overlain by the Kalambaina Formation accumulated in the Sokoto embayment to the north. The occurrence of *Gisortia brevis* Douvillé (Parker, 1964; Adegoke, 1972a, 1972b, 1973) and identical Paleocene ostracodes (Reyment, 1965a, fig. 11) in both areas suggest direct communication.

Apart from the few species in common, significant differences existed between the faunal aspect of the Saharan area and that of the coastal area during the Paleocene. This suggests the establishment of some degree of provincialism. Hence the writer suggested



4. Generalized map showing the break-up of the trans-saharan epeiric sea during late Paleocene of early Eocene (?)



5. Map of southern Nigeria showing the outcrop pattern of Paleocene and younger sediments

(Adegoke, 1969b) that the southern connection broke up sometime before the end of the Paleocene (Text-fig. 4). A similar, though rather far-fetched idea, was implied by Buser (1966, p. 31) who suggested that the identical microfaunas may owe their dispersal to birds and fishes rather than to the Maestrichtian-Paleocene transgression. Continued search in the Niger Valley may yet reveal uneroded pockets that would give a more accurate clue to the time of closure of the southern pass.

The extensive Maestrichtian-Paleocene transgression finally gave way in late Paleocene or, at best, earliest Eocene to a general regression culminating in the complete break up of the trans-saharan epeiric sea and the formation of numerous inland basins (Text-fig. 4) which subsequently filled up with fluviatile and lacustrine sediments derived mostly from the north (Greigert, 1965). In the west, two formations were laid down in middle to late Eocene times, the phosphate and fish-bearing Oshosun Formation which is overlain by the Ilaro Formation. The facies relationship of both units were carefully mapped by Jones (Jones and Hockey, 1964). Contemporaneously in the east, greenish-gray clayey sandstones with bands of fossiliferous concretions near the base (the Ameki Formation) were deposited. The upper part consists of purplish and blue lagoonal mudstone and claystone.

Post-Eocene strata (Ogwashi-Asaba and Benin Formations) are dominantly terrigenous sequences that were laid down uniformly throughout southern Nigeria in an arcuate belt which migrated seaward as the strandline shifted gradually to the south (Text-fig. 5). This regression still continues today having been interrupted only by the oscillations associated with the Holocene eustatic rise in sea level (Short and Stauble, 1967, fig. 6).

From the foregoing, the southern Nigerian basin had two major marine connections: (1) with the Tethys and North African area through the trans-saharan epeiric sea established between the Cenomanian (Reyre, 1966) and late Paleocene and (2) with other west African basins through the proto-Atlantic Ocean in which normal marine sediments were first laid down during the Albian. This interesting paleogeography had a profound influence on the fauna. The neighboring basins shared several identical species in common and their fauna as a whole showed a remarkably close affinity with the marginal Tethyan faunas of India, Egypt, Gulf Coastal United States, Trinidad, and Brazil (Adegoke, 1972a, 1972b, 1973).

STRATIGRAPHY

Three stratigraphic units are recognizable in the section exposed at the Ewekoro quarry. They are in stratigraphic order:

Oshosun Formation
Akinbo Formation
Ewekoro Formation

They are diagrammatically represented in the columnar section in Text-figure 6.

EWEKORO FORMATION

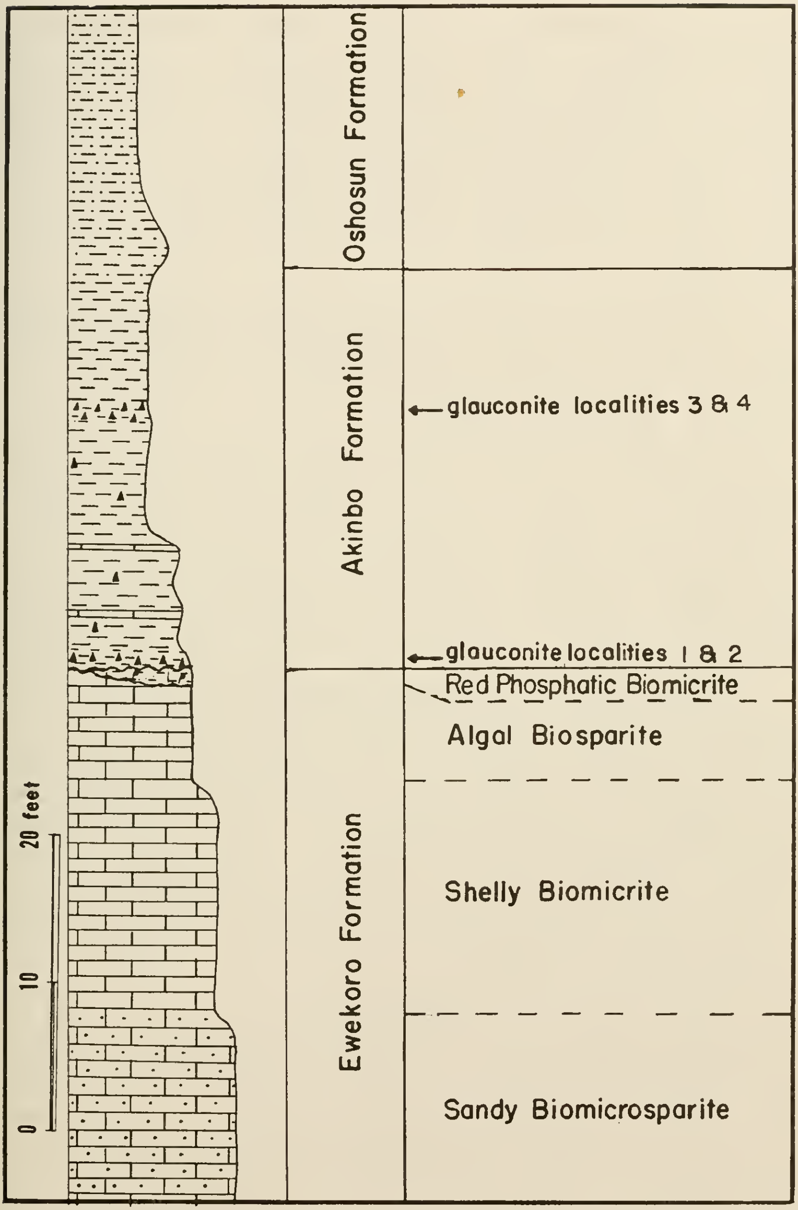
The Ewekoro Formation at the type locality consists of about 10-12.5 m of pure, coquinoidal limestone which is sandy near the base, shelly in the middle and marly near the top. Apart from the quarry section, outcrops are rare, and as a result much of the knowledge of the formation is based on boreholes.

The formation was named by Jones (*in* Jones and Hockey, 1964) who proposed "Ewekoro between Itori and Papa-Alanto" as the type locality. His proposed type section was a composite of two boreholes, the Geological Survey of Nigeria boreholes 1582 and 1583 located at Akinsinde about 10 miles SSW of Ewekoro (Geol. Sur. Nigeria, Sheet 68, 1:250,000, *in* Jones and Hockey, 1964).

There are two major objections to Jones' type designations:

1. A formation should validly have only one type section (American Code of Stratigraphic Nomenclature, 1961). Inasmuch as each of Jones' composite sections is complete, and his action was merely intended to attain maximum thicknesses, his composite type section is considered invalid.
2. The type section should be located within the geographical limits of the designated type locality. If we accept Jones' designated type locality as broadly including the areas in the immediate vicinity of Itori and Papalanto, his type section at Akinsinde falls at least six miles outside the limit of this area. For these reasons, neither of Jones' boreholes can be validly selected as type section.

Reyment (1964) published a short review of Nigerian Cretaceous-Cenozoic stratigraphy almost concurrently with Jones' work



6. Columnar section showing the strata exposed in the Ewekoro quarry, the four microfacies units and the positions of the radiometrically dated glauconite beds

in which he used the name Ewekoro Formation with the Ewekoro area also designated as the type locality. His usage, however, differed from that of Jones in that he designated the limestone exposed in the quarry at Ewekoro as the type section. One other major contradiction was apparent in Reyment's usage. Jones included the limestone as well as about 400 feet of overlying shale in the Ewekoro Formation, whereas Reyment restricted the formation to the limestone only.

Reyment (*op. cit.*) made no reference to Jones' paper though he drew heavily on the material included in it. In a subsequent monograph Reyment (1965a) cited Jones' paper but failed to give him priority for naming the Ewekoro Formation (Reyment, 1965a, pp. 90, 91, fig. 12; p. 100, Ilaro Formation).

The degree to which Reyment (1964, 1965a) drew on Jones' work leaves little doubt that Jones' usage had priority (Adegoke, 1969b). Hence Adegoke and others (1971, Proc. Colloquium 1970) accepted Jones' designation of the Ewekoro area as the type locality but accepted Reyment's subsequent selection of the section in the Ewekoro quarry as type because Jones' type section is considered invalid.

All subsequent workers except Antolini (1968) and Fayose and Asseez (1972) have supported Reyment's separation of the limestone from the overlying shale, according formational status to both (Adegoke, 1969b; Adegoke and others, 1971, Proc. Colloquium 1970; Ogbe, 1970, 1972). Antolini (*op. cit*). merely accepted Jones' original usage, whereas Fayose and Asseez (*op. cit.*) suggested that both be considered as members and referred to the Imo Formation, a predominantly shaly unit whose type section outcrops along the Imo River in Eastern Nigeria.

Erection of separate formational status for the limestone and the shale is justified by the following facts:

1. Both are lithologically distinct and almost exclusive. The Ewekoro Formation is a massive limestone lacking interbedded shale (Pl. 1, fig. 2; Pl. 2, fig. 3) while the overlying shale is laminated and, except at the base, lacks prominent calcareous bands (Pl. 2, figs. 1, 4, 5).
2. Both units are mappable and traceable in the subsurface for several miles from Western Nigeria as far as Ghana to the west

(Jones and Hockey, 1964, fig. 14; Slansky, 1962; Oppenheim, 1915; Cox, 1952).

3. Though the limestone grades laterally into shale, it is, in the Ewekoro area, overlain by the shale (Jones and Hockey, 1964; Adegoke, 1969b; Murat, 1972) and both are separated by a major disconformity conspicuously indicated by the scoured and deeply potholed erosional surface of the limestone (Pl. 3, fig. 1).

The extensive accumulation of phosphatic nodules (about 23 cm) and glauconites (about 23 cm) above this unconformable surface (see Text-fig. 6) suggests that the hiatus may represent considerable geologic time. The significance of phosphates and glauconites as indicators of hiatuses has been emphasized by several workers (Goldman, 1923; Stephenson, 1929). The degree of erosion of the limestone and the complete change in depositional regime without any gradation further attest to the magnitude of the break.

Only the upper 10 m of the limestone is exposed in the quarry area. The base consists of a light brown to gray sandy biomicrosparite limestone with few bioclastic fragments (Pl. 3, figs. 6, 7). Stratification is evident and is accentuated by local variations in the quantity and size of the interbedded quartz and glauconite grains. The formation becomes more sandy towards the base.

The gradational aspect of the base of the Ewekoro Formation with the top of the predominantly sandy Abeokuta Formation was emphasized by Jones (1964, p. 66), whose conclusion was based on petrographic examination of all boreholes which penetrated the limestone in southwestern Nigeria. Our re-evaluation of much of the material confirmed his conclusions (Adegoke and others, 1971). Fayose and Asseez (1972), however, claimed that the limestone is "bounded on top and bottom by the shale member." They quoted three Geological Survey of Nigeria borehole logs two of which clearly recorded that the base of the limestone is sandy. The log of the Akinsinde borehole, the main material studied by them, similarly shows that the base of the limestone becomes more sandy than the higher portions.

The sandy basal unit grades upward into massive gray limestone with abundant shells, echinoids and corals, and little terrigenous matter (Pl. 3, figs. 3-5). This unit yielded most of the fossils studied in this report. The limestone is coarse-grained and intensive recrystallization is the rule. The unit becomes less shelly and finer-grained near the top, passing abruptly into the overlying algal limestone.

The algal limestone is a fine-grained, nodulated, poorly fossiliferous unit. It shows local depositional features such as current-bedding (Jones and Hockey, 1964; pl. 2A). In much of the quarry, it is the uppermost exposed limestone unit. Locally, however, it is overlain by thin, erosional remnants of a red, phosphatic limestone. The upper surface of the limestone is intensively water-worn, scoured and deeply potholed. This disconformable surface marks the top of the Ewekoro Formation.

The extent of the Ewekoro Formation in the subsurface is not known precisely. Along strike, it has been traced almost continuously from Ghana in the west as far as Ibonwon near Ijebu-Ode, western Nigeria, a distance of over 200 miles (Jones and Hockey, 1964). Beyond that area there is no published information. It probably thins out rapidly eastward, finally pinching out against the western flank of the Okitipupa Ridge (Adegoke, 1969b, fig. 5). Should this assumption prove correct, the limestone is underlain gradationally everywhere in inland western Nigeria by sandstone (Murat, 1972, p. 261). In the more coastal areas (for which there is presently little published information) and westward in Togo and Dahomey (Slansky, 1962) it may locally be underlain by shale. The limestone which crops out on the Fresco cliffs of Ivory Coast has identical microfaunas and may represent the western most extent of the formation.

The southern limit of the unit is unknown. It was not encountered in any of the coastal boreholes which penetrated the same horizon (Reyment, 1965a; Fayose, 1970).

Though the limestone section exposed at the Ewekoro quarry is texturally and faunistically representative of the unit, its thickness (10-12.5) is by no means so. Twenty-one boreholes in the vicinity of Ewekoro indicate an average thickness of 48-50 feet (ca. 17 m). In Ajido and Onigbedu areas west of the type locality, the thickness averages 51 feet (ca. 17 m). East of the type area, it maintains a uniform thickness for about 30 miles. A thickness of about 52 feet (ca. 17.2 m) was recorded near Shagamu. Jones (Jones and Hockey, 1964, p. 66) recorded a thickness of 100 feet (ca. 33.5 m) in the borehole at Akinsinde and 103 feet (ca. 34 m) at Ibeshe.

AKINBO FORMATION

The shale which in the Ewekoro area overlies the Ewekoro Formation and into which the limestone grades laterally was included in the Ewekoro Formation by Jones (*op. cit.*). Reyment (1964, 1965a, 1965b) separated it from the limestone and assigned it to the Imo Shale whose type section is along the Imo River in eastern Nigeria (Adegoke, 1969b, fig. 6). Reyment's usage has been followed by most subsequent workers (Adegoke, 1969b; Fayose, 1970).

Recently, Ogbe (1970, 1972) following a suggestion made earlier by Jones (1964, p. 57), demonstrated that the shales on either side of the Okitipupa Ridge differed markedly from each other in their physical features and to a lesser degree faunally. He, therefore, proposed the name Akinbo Formation for the unit on the western side of the ridge and selected the section exposed in the Ewekoro quarry as the type.

The type section varies in thickness between 7 and 12 metres. Its base lies at the top of the 23 cm phosphatic bed whose erosional surface marks the top of the limestone. The phosphate is, in turn, overlain by a glauconitic shale less than 30 cm thick. Another glauconite band occurs about 3 metres higher (see Text-fig. 6).

The shale has a greenish-gray color with thin bands and lenses of limestone near the base. The upper part of the formation becomes more silty and sandy as it grades into the base of the overlying Oshosun Formation.

OSHOSUN FORMATION

Only the lower 2-5 metres of the basal Oshosun Formation is exposed in the Ewekoro quarry. Characteristically, it is a dull red, siliceous, and sandy mudstone with sandy pockets. It is continental in character and lacks fossils. In the quarry area, a characteristic dendritic drainage pattern (Pl. 2, fig. 2) is developed on this formation. Its contact with the underlying Akinbo Formation is gradational.

STRUCTURE

The Ewekoro area is structurally simple. Apart from the steeply dipping current bedding features developed locally in the algal limestone (Jones and Hockey, 1964, pl. 2A) and minor flexures caused by quarrying recorded by Reyment (1965a), no major structures are known. The beds show a gentle dip of less than 2° to the south.

PETROGRAPHY AND MICROFACIES

In our earlier study (Adegoke and others, 1971, Proc. Colloquium 1970), we erected three microfacies units for the Ewekoro Formation, a sandy biomicrosparite at the base, overlain in turn, by the shelly biomicrite, and the algal biosparite. More recently, Ogbe (1972) proposed a fourth unit, the red phosphatic biomicrite, for the erosional remnant of the red phosphatic limestone that locally caps the algal biosparite.

Our classification of facies was based on the works of Folk (1959, 1965), Klein (1963), Bathurst (1964), Dodd (1966), Vatan (1967) and Purdy (1968), and the units are represented diagrammatically in Text-figure 6.

SANDY BIOMICROSPARITE

Plate 3, figures 6, 7. This is the lowest unit excavated in the Ewekoro quarry. Only the upper 9-10 feet are exposed in the quarry. The base is not exposed and knowledge of it is based partly on borehole material.

This a light brown to brownish-gray, banded limestone with bioclastic fragments regularly dispersed within a matrix of sparry calcite. These fragments include algae, pelecypods, gastropods, echinoids and corals. The upper-most three feet is slightly more fossiliferous than the lower portion.

Most allochems show recrystallization as a result of *in situ* aragonite-calcite conversion accompanied by preservation of original wall structure. This affected most of the ostracodes, Foraminifera, pelecypods, gastropods and algae. The type II solution-deposition conversion of Dodd (1966) affected some mollusks resulting in the obliteration of the boundaries between the fossils and adjacent voids. Most pelecypods, gastropods, echinoids, and their spines and spicules, however, show the type III solution-deposition conversion in which vugs and primary pores were filled with calcite prior to the solution-conversion of the fossils. In these cases, the boundaries between the vugs and fossils are clearly delimited by dark micrite envelopes. In certain algae and most mollusks, the shell material was subsequently dissolved and the micrite envelope filled with secondary sparry calcite.

The matrix, originally ooze, is also recrystallized and the pore spaces filled with sparry calcite. In thin section, the original micrite of the ooze is still visible locally (Adegoke and others, 1971, Proc. Colloquium 1970, pl. 1).

Two dimensions of stratification were recognized:

(1) A macro-layering ranging in thickness between 4 and 8 cm. The boundaries between these layers constitute the weak bedding planes along which the strata part readily in subparallel layers.

(2) A micro-layering consisting of laminae and microlaminae 1-3 mm thick. These are rendered readily visible to the naked eye by the variation in the quantity and size of the contained quartz and glauconite grains.

Between the micro-layers are occasional "structureless" layers, 1-2 mm thick, lacking visible banding. These are generally richer in bioclastic fragments than the laminated portions.

Insoluble residue study indicates the presence of quartz, glauconite, and grains of limonite with quartz predominating. The grains are well sorted indicating deposition in a high-energy environment.

SHELLY BIOMICRITE

Plate 3, figures 3-5. This unit, composed of a pure, shelly limestone, constitutes the bulk of the strata exposed in the quarry. It is also the material used most in the cement works. About six-seven metres were measured (Pl. 1, figs. 2, 3), and it grades into the underlying sandy biomicrosparite.

The shelly unit is a light brownish-gray bioclastic limestone with abundant gastropods, pelecypods, echinoids, crustaceans, scaphopods, nautiloids, bryozoans and corals (in order of relative abundance). Vertebrates are sparsely represented by ray tooth plates, isolated shark teeth, and bones (Pl. 50, figs. 24-35). The bulk of the macrofossils studied in this report weathered out of this unit.

Many of the shells were broken or heavily abraded prior to deposition (Pl. 3, fig. 5), and most had undergone recrystallization. The corals especially show the universal occurrence of aragonite to calcite inversion (Purdy, 1968), a phenomenon which also affected the Foraminifera. Most allochems, especially the mollusks, were dissolved during diagenesis with the original shell replaced by drusy calcite. The echinoids and nautiloids also show recrystallization usually with preservation of original wall structure. The voids within the shell frequently show large secondary crystals (Pl. 9, figs. 5, 6). Most of these secondarily formed crystals are large, some measuring over 5 mm in diameter. An entire recrystallized gastropod shell may sometimes contain as few as three to five large crystals (Pl. 3, fig. 4; Adegoke and others, 1971, pl. 2, fig. 2).

The matrix is micrite and contains only a small amount of terrigenous material. Quartz grains are generally present in small quantities though occasional sandy pockets are encountered. Locally, voids in the matrix are filled with sparry calcite with radially oriented fibers which are often in continuity with the fibrous calcite of the fossils.

The fossil content, which includes several shallow water and littoral taxa, *e.g.* neritids (*Velates nigeriensis,* new species), the worn nature of the bioclastic fragments and their good sorting indicate accumulation under a high-energy, littoral to shallow-shelf condition.

ALGAL BIOSPARITE

Plate 3, figures 1, 2. This is the topmost limestone unit exposed in much of the quarry. It overlies the shelly biomicrite with a sharp contact and is readily distinguished from it by its low bioclastic content. The top is eroded, scoured, and deeply potholed except where it is overlain by remnants of the red phosphatic limestone. Its thickness thus varies considerably, averaging about 1.5 metres.

Channel-fills and high-energy crossbedded units are locally common (Jones and Hockey, 1964, pl. 2A). These may represent deposition under very agitated conditions in a channel (Klein, 1963). Local washouts are also common. The cavities and potholes are filled with shale (derived from the overlying formation) and glauconitic marls.

This unit is a light brownish-gray limestone with few macrofossils. Echinoids and algae are, however, abundant. Most allochems are recrystallized with retention of the original structure. *In situ* aragonite-calcite conversion (type III solution-deposition conversion of Dodd, 1966) is the rule. Some gastropods show a modified type III-type II conversion in which the boundaries of the fossils are still discernible despite the fact that they partially merge with the calcite of the matrix. Some gastropod and pelecypod shells have been dissolved and the voids thus formed are filled with secondary drusy calcite. The recrystallization also affected the matrix.

Several thin calcite veins cut across the allochems and matrix, indicating that there may have been more than one cycle of solution and recrystallization (Adegoke and others, 1971, Proc. Colloquium 1970, pl. 3, fig. 3).

The rounded-subrounded nature of the fragmentary allochems, the fair degree of sorting and the local occurrence of channel-fills and crossbedded limestone indicate accumulation in a high-energy environment.

RED PHOSPHATIC BIOMICRITE

Text-figure 6. This microfacies unit was proposed by Ogbe (1970, 1972) for the topmost thin limestone locally exposed in the Ewekoro quarry. It occurs in patches as erosional remnants on the algal biosparite and its absence locally is due to complete removal by erosion. Where exposed, it is scoured and deeply potholed. Ogbe recorded a thickness ranging from 0 to about 45 cm.

It is a red, dense limestone, very rich in glauconite, phosphate, and bone fragments. Mollusks, corals, crustaceans, echinoids and Foraminifera also occur in smaller numbers. Its fauna is generally reminiscent of that of the shelly biomicrite though far less abundant.

Ogbe (*op. cit.*) reported the occurrence of both types II and III aragonite-calcite inversion affecting most of the mollusks, corals, spines, and spicules. The matrix is micrite with abundant silt and clay-sized phosphatic material. About 20-30 percent of the original micritic matrix has been secondarily replaced by sparite.

FAUNA

The macrofauna collected and examined from the Ewekoro Formation in this study contains 221 determinable species. These include 3 determinable echinoid species, 125 gastropod species representing 78 genera, 76 pelecypod species representing 43 genera, 6 nautiloid, 3 scaphopod and 1 brachyuran species. Most of the taxa (169 species, 6 subspecies) are new. The coral fauna, consisting of about seven species of solitary and colonial forms, is being studied by F. G. A. Ogbe and is, therefore, excluded from the systematic section of this study.

Many additional new species represented by poorly preserved, fragmentary, or otherwise inadequate material were not named. Because of the diversity of the indeterminate taxa and the absence in the study material of a number of large forms, *e.g. Crassostrea*, which are seen in the field to be major constituents of the fossilized assemblage, it is apparent that sustained collecting will, in the future, lead to a considerable increase in the number of fossil species from the Ewekoro Formation. The writer estimates that a fauna containing over 400 species will probably be found as more areas of the quarry are opened up.

PROVENANCE AND PRESERVATION

Most of the Ewekoro fossils were derived from the second limestone microfacies unit, the shelly biomicrite (Text-fig. 6, Pl. 3, figs. 3-5). This unit is almost entirely composed of a pure shelly limestone with negligible amounts of terrigenous material. It is highly indurated, a factor necessitating repeated blasting during quarrying. Extensive recrystallization has taken place (see Petrography and Microfacies). These factors, as well as the common occurrence of type II solution-deposition conversion of aragonite to calcite in which allochem and matrix interfaces have intergrown, make it virtually impossible to pry or chip out fossils from the exposed bedrock. Absolute reliance was, therefore, placed on natural agents of weathering.

Most of the shells weather out in a near-perfect state with much of the exterior sculpture still preserved. This is due primarily to the predominance of the type III aragonite to calcite inversion in which primary vugs and pores were filled with calcite prior the solution-conversion of the fossils and the fact that the shell-matrix interface is often lined by a thin dark micrite layer.

The echinoids were the least affected by these diagenetic processes as they have details of the exterior sculpture almost perfectly preserved despite their minute sizes (Pls. 4, 5). They were followed closely by the mollusks. The corals, Foraminifera and ostracodes were, however, adversely affected by the recrystallization.

Phosphatic material was, in general, poorly preserved in the Ewekoro environment. The brachyuran, *Callianassa*, though apparently abundant, is represented by poorly preserved molds of the claws only. The rare occurrence of well-preserved fish and other vertebrate bones may also be due to poor preservation.

COMPOSITION OF THE EWEKORO FAUNA

(a) Macrofauna

The Ewekoro macrofauna, though reasonably diverse, is greatest in mollusks, other phyla being only sparsely represented.

The molluscan assemblage is dominated by gastropods not only in species diversity but also in total number of individuals. The gastropod-pelecypod species ratio is almost 2 to 1 and the numerical abundance ratio is over 10 to 1. The greatest gastropod species diversity is seen among the microscopic size forms.

A few genera show a great diversity in total number of species though rarely accompanied by a commensurate abundance in number of individuals. Among these may be mentioned *Pseudomalaxis, Afrollonia,* new genus, *Heligmotoma, Pseudoliva, Rimella, Cerithiopsis, Ewekoroia,* new genus, *Architectonica, Sycostoma,* and the related new genus *Parkeristoma.* The Turritellidae are especially diverse being represented by a new genus *Reymentella* and species of *Mesalia* (seven species), *Haustator* (three species), and *Torquesia* (two species) and a number of indeterminate new forms.

While most of the gastropod species are represented by a modest number of individuals, *Pseudaulicina simplex, Clinuropsis togoensis, Pseudoliva (Buccinorbis) guineensis,* new species, *Volutilithes (Afrovolutilithes) uniplicata, Agaronia togoensis, Clavilithes (Cosmolithes) dessauvagiei,* new species, *Strepsidura kerstingi, Reymentella olaniyani,* new species, *Solariella adedayoi,* new species, *Cylichna makanjuolai* new species, *Afrollonia nigeriensis,* new species, *Pseudoliva funkeana,* new species and the turritellids are exceptional in being represented by a large number of well-preserved individuals.

Bivalves are in general less diverse and less numerous than gastropods. The genera *Ostrea, Venericardia, Macrocallista, Corbula, Glycymeris,* and *Cardium* show a diversity both in the number of species and (except for *Glycymeris*) number of individuals. *Cardium zechi* Oppenheim and *Corbula nigeriensis,* new species, are the most abundant.

The Ewekoro Formation is rich in nautiloids. A total of six species was collected, one of *Deltoidonautilus* and the rest referrable to *Cimomia,* including a new subgenus *Afrocimomia.* This constitutes the most diverse nautiloid fauna ever recorded from sub-Saharan Africa (Miller, 1951). The great diversity negates Reyment's (1966d) suggestion that empty nautiloid conchs drifted to the Nigerian and West African coast from the Cabinda enclave in the south (Adegoke, 1972a).

Scaphopods are represented by three species mostly referrable to the subgenus *Laevidentalium*.

The Echinodermata are represented in the Ewekoro Formation by a probable crinoid stem fragment, an indeterminate spatangoid, an indeterminate fragmentary echinoid plate, and three determinate species: *Togocyamus seefriedi, Cassidulus kieri,* new species and *Thylechinus tessieri,* new species. Two large spines collected from the limestone debris indicate the probable presence of additional cidaroid species not represented by plates. Among the echinoids the minute *Togocyamus* is most abundant and is probably the most important element of the Ewekoro benthic assemblage. Over 2,000 individuals were collected. *Cassidulus kieri,* new species, is also abundantly represented by about 30 specimens including one aberrant individual with four ambulacral areas (Pl. 5, figs. 12-14).

Corals are represented in the Ewekoro fauna by seven species, one each of the genera *Schizosmilia, Tiarasmilia,* and ?*Stylina,* three species of *Conocyathus* (including a new subgenus), and a probable new genus in the family Astrocoenidae (Ogbe, 1976).

The corals are mostly small and even the colonial forms rarely attained more than a modest size. The absence of major reef-building and larger solitary forms in the Ewekoro sea is probably not totally unconnected with the general absence of coral development of the West African shelf today. The major ecological factor responsible for this is the influence of the cold Benguela Current. This suggests that the existing oceanographic conditions may have persisted in West Africa since early Paleogene times.

Vertebrates are sparsely represented in the limestone mostly by teeth and denticles of *Myliobatis, Odontaspis,* and other unidentified ray denticles (Pl. 50). Bones and teeth are rare in the limestone but abundant in the phosphate bed overlying the limestone.

(b) Microfossils

Though Reyment never studied the paleontology of the Ewekoro Formation in detail, he, nonetheless, emphasized the occurrence of "white marls rich in microfossils" interbedded with the bands and lenses of shelly limestone (Reyment, 1965a, p. 90). This conclusion was refuted by Fayose and Asseez (1972), who claimed that diagnostic microfossils were rare in the quarry. They misquoted Reyment (1965a, *loc. cit.*) and consequently contended that it was impossible to derive information on the age or paleoecology of the formation without resort to presumably more fossiliferous "nearby boreholes."

Our study of the Ewekoro quarry, by contrast, revealed the presence of a diverse microfauna. Ogbe (1970) recorded the following Foraminifera from the limestone exposed in the quarry:

Anomalina spp.
Bulimina sp. cf. B. *alazanensis* Cushman
Bulimina sp. cf. *B. lateroconcava* de Klasz and Rerat
Bulimina (Praebulimina) sp. cf. *B. opima* de Klasz, Magne and Rerat
Cancris sp. cf. *C. auriculus* Fitchel and Moll
Cibicides americanus Graham and Classes
Cibicides sp. aff. *C. alleni* (Plummer)
Cibicides spp.
Dentalina sp. cf. *D. bifurcata* d'Orbigny
Dentalina sp. cf. *D. hexacostata* Howe
Dentalina sp. cf. *D. inepta* Cushman
Dentalina sp. cf. *D. mucronata* Neugeboren
Dentalina sp. cf. *D. soluta* Reuss
Dentalina sp. aff. *D. wilcoxensis* Cushman
Dentalina spp. A-D.
Discorbis sp. cf. *D. frescoensis* Lys
Discorbis spp.
Eponides elevatus (Plummer)
Eponides plummerae Cushman
Eponides vanbelleni (van den Bold)
Eponides spp.
Globigerina triloculinoides Plummer
Globorotalia pseudobulloides (Plummer)
Globorotalia varianta (Subbotina)
Globorotalia spp.
Globulina spp.
Gyroidina spp.
Lagena sp. cf. *L. acuticosta* Reuss
Lagena sp. cf. *L. globosa* (Montagu)
Lagena sp. cf. *L. vulgaris* Williamson
Nodosaria sp. cf. *N. latejugata* Gumbel
?*Nodosaria* sp. cf. *N. semispinosa* Le Roy
Nodosaria sp. B.
Quinqueloculina spp. A-F.
Robulus sp. C.
Rotalia sp. cf. *R. guinezonensis* Lys
Vaginulina sp. cf. *V. icenii* Haynes
Vaginulina longiforma (Plummer)
Vaginulina sp. aff. *subrotunda* ten Dam
Vaginulina spp. A-E
Virgulina sp.

The foraminiferal fauna is much richer than indicated by the list, because several genera were represented by as many as four to six species (*e.g. Quinqueloculina* spp. A-F, *Vaginulina* spp. A-E, *Dentalina* spp. A-D), which Ogbe declined to name until he completed his studies of other inshore and offshore boreholes from the same area. To this list also may be added the few species recorded at various times by Reyment (1965a, 1966a) from the quarry.

The Ewekoro material also yielded a moderately diverse ostracode fauna from which Dr. M. Ebi Omatsola of the Palaeontological Institute, Uppsala, Sweden, (now with Shell-BP Co., Lagos) (personal communication, Dec. 4, 1970) identified the following:

Bairdia ilaroensis Reyment and Reyment
Bairdia sp.
Bythocypris sp.
?*Buntonia (Buntonia) attitogoensis* Apostolescu
Buntonia (Buntonia) beninensis Reyment
Buntonia (Buntonia) pulvinata Apostolescu
Buntonia (Protobuntonia) triangulata (Apostolescu)
Buntonia (Protobuntonia) apatayeriyerii Reyment
Cophina, n. sp.
Cythereis deltaensis Reyment
?*Cythereis*, n. sp.
Cytherella (Cytherella) beyrichi Reuss
Cytherella (Cytherella) sylvesterbradleyi Reyment
Cytherella (Cytherelloidea) araromiensis Reyment
Cytherella sp.
Cytheropteron sp. A.
Cytheropteron sp. B
Eocytheropteron, n. sp.
Leguminocythereis bopaensis (Apostolescu)
Leguminocythereis sp.
"*Mehesella biafrensis*" Reyment
Nigeroloxoconcha sp. cf. *N. oniseguni* Reyment
Nigeroloxoconcha, n. sp.
Ovocytheridea sp.
Paracypris nigeriensis Reyment
Paracypris sp.
Paijenborchella sp.
Quadracythere lagaghiroboensis Apostolescu
Veenia (Veenia) acuticostata Reyment
Veenia (Veenia) ornatoreticulata Reyment
?*Veenia (Veenia) warriensis* Reyment

He noted also the presence of several new taxa which he declined to name until additional material became available.

NEW SUPRASPECIFIC TAXA PROPOSED

The Ewekoro Fauna is largely new. It contains a large number of supraspecific taxa not previously recorded. Three new families, nine new genera (eight in the Gastropoda, one in the Pelecypoda) and 13 new subgenera (10 in the Gastropoda, two in the Pelecypoda and one in the Cephalopoda) are proposed. These are listed alphabetically below with the type designations.

NEW FAMILIES

Family	Superfamily	Type Genus
	Gastropoda	
Ewekoroiidae	?Cerithiacea	*Ewekoroia*, n. gen.
Heligmotomidae	Buccinacea	*Heligmotoma* Mayer-Eymar
Vanpalmeriidae	Volutacea	*Vanpalmeria*, n. gen.

NEW GENERA

Genus	Family	Type Species
	Gastropoda	
Afrollonia	Turbinidae	*Afrollonia nigeriensis*, n. sp.
Druidwilsonia	Cerithiidae	*Druidwilsonia nigeriana*, n. sp.
Wendella	Cerithiidae	*Wendella nigeriensis*, n. sp.
Ewekoroia	Ewekoroiidae	*Ewekoroia nigeriensis*, n. sp.
Vanpalmeria	Vanpalmeriidae	*Vanpalmeria africana*, n. sp.
Parkeristoma	?Buccinidae	*Parkeristoma guineensis*, n. sp.
Reymentella	Turritellidae	*Reymentella olaniyani*, n. sp.
Vincenturris	Turridae	*Vincenturris woodringi*, n. sp.
	Pelecypoda	
Sootryenella	?UNCERTAIN	*Sootryenella ewekoroensis*, n. sp.

NEW SUBGENERA

Genus	New Subgenus	Type Species
	Cephalopoda	
Cimomia	*Afrocimomia*	*C. (A.) ewekoroensis*, n. sp.
	Gastropoda	
Cornulina	*Afrocornulina*	*C. (A.) africana*, n. sp.
Volutilithes	*Afrovolutilithes*	*V. (A.) uniplicata* Furon
Heligmotoma	*Douvilletoma*	*H. (D.) oluwolei*, n. sp.
Strepsidura	*Eamesidura*	*S. (E.) newtoni*, n. sp.
Pseudomalaxis	*Ewekorolaxis*	*P. (E.) ewekoroensis*, n. sp.
Pseudomalaxis	*Platylaxis*	*P. (P.) nigeriensis*, n. sp.
Pseudomalaxis	*Nigerialaxis*	*P. (N.) fayosei*, n. sp.
Cerithium	*Nigerithium*	*C. (N.) coorayi*, n. sp.
Rapana	*Nigerapana*	*R. (N.) ewekoroensis*, n. sp.
?Odostomia	*Ravnostomia*	*?O. (R.) selandica* Ravn
	Pelecypoda	
Anodontia	*Afranodontia*	*A. (A.) marginodentata*, n. sp.
Glycymeris	*Ewekoromeris*	*G. (E.) ewekoroensis*, n. sp.

AFFINITIES OF THE EWEKORO FAUNA

The Paleogene faunas of the West African coastal basins are of immense paleozoogeographic interest, showing as they do, closer affinity with the marginal Tethyan faunas of distant areas such as India, Egypt, Gulf Coastal United States, and Trinidad than with the contemporaneous faunas of neighboring North Africa and South Africa (Locard, 1889; Peron, 1889; Moret, 1938; Kaiser, 1926).

The Paleocene fauna of the West African province is homogeneous judging from the large number of species shared in common between the different basins. The Ewekoro fauna is virtually identical with the fauna recorded by Cox (1952) from the Apatuema Limestone in Ghana. Eighteen of the 27 species recorded by him occur also in Ewekoro. Similarly 42 of the 59 species recorded from the Adabion and Togblékové beds of Togo by Oppenheim (1915) and Furon (1948) occur at Ewekoro, indicating a faunal identity of almost 70 percent. The identity may be greater as Furon's illustrations and brief descriptions make closer comparison of some species almost impossible.

At least 20 species occur in common between the Paleocene horiozns of Senegal (Tessier, 1949, 1952, Chabaglian, 1959) and the Ewekoro fauna (Table 1).

Although the contemporaneity of the Landana beds and the Ewekoro strata is not in doubt, both share only one species, *Clinuropsis diderrichi* Vincent in common. A number of other taxa are closely comparable. For example, *Cimomia landanensis, Vermetus landanensis,* and *Ampullina tapina* from Landana are comparable with *C. reymenti,* new species, *V. nigeriensis,* new species, and *Ampullina tapina kogbei,* new subspecies, from Ewekoro. The general dissimilarity of the bulk of the fauna and the more southerly aspect of the Landana fauna led the writer to suggest (Adegoke, 1972b, 1972c) that the Landana area was outside but close to the southern limit of the West African zoogeographic province during the Paleocene.

The Ewekoro fauna similarly shares only one species, *Mesalia salvani,* new species, in common with the Paleocene of Morocco (Salvan, 1954). A large number of their taxa are, however, comparable and the generic composition is virtually identical. Morocco is thus considered outside the northern limit of the West African Paleocene zoogeographic province.

The table below summarizes the geographic distribution of the more important species found in many West African basins.

The degree of relationship between the Ewekoro fauna and the Mokattam fauna of Egypt and the upper Ranikot fauna of India (Oppenheim, 1903, 1906; Cossmann and Pissarro, 1909, 1927; Cox, 1930) has been emphasized by most earlier workers (Oppenheim, 1915; Douvillé, 1920; Newton, 1922). The identity was so great that Douvillé (*op. cit.*, p. 122) coined the term *indo-africaine* to express it. Oppenheim (1915) similarly correlated the Togolese fauna with the so-called "Libyan Stage" of Egypt.

Table 1. — Paleocene species common to many West African Paleogene basins.

ECHINOIDEA	NIGERIA	TOGO	GHANA	SENEGAL
Togocyamus seefriedi Oppenheim	X	X	X	X
DECAPODA				
Callianassa seefriedi von Ammon	X	X	X	?
GASTROPODA				
Afrollonia togoensis, n. sp.	X	X		
Agaronia togoensis Furon	X	X		
Architectonica togoensis (Furon)		X		X
Clinuropsis diderrichi Vincent[1]	X	X	X	X
Clinuropsis togoensis (Oppenheim)	X	X		
Crommium kouriatchyi Furon		X		X
Euspira togoensis (Furon)	X	X		X
Ewekoroia acirsoides (Furon)	X	X		
Galeodea kouriatchyi Furon		X		X
Gisortia brevis Douvillé[2]	X			X
Hipponix demissus Cox	?		X	
Keilostoma septemzonatum Cox	X		X	
Levifusus palaeocenicus Furon	X	X		
Mesalia fallockensis Tessier	X			X
Norrisia (Norrisella) aurilitoralis Cox	?		X	
Oniscidia chavani (Furon)	?	X		X
Potamides trituberculatus Cox	X	?	X	
Pseudaulicina simplex (Furon)	X	X	X	
Rimella ewekoroensis, n. sp.	X	X		
Rimella subhumerosa (Oppenheim)	X	X	X	X
Strepsidura kerstingi Oppenheim	X	X		
Tibia (?Amplogladius) oppenheimi, n. sp.	X	X		
Tornatellaea (Ravniella) africana Furon	X	X		X
Torquesia adabionensis (Oppenheim)	X	X		
Torquesia oppenheimi, n. sp.	X	X		
Volutilithes (Afrovolutilithes) gruneri Oppenheim	X	X		
Volutilithes (Afrovolutilithes) uniplicata Furon	X	X		X
PELECYPODA				
Arca (Arca) accra Cox	X		X	?
Barbatia (Acar) putealis Cox	X		X	
Cardium (Cardium) guineense, n. sp.	X	X		?
Cardium (Cardium) zechi Oppenheim	X	X		?
Corbula atlantica Furon	X	X		X
Diplodonta adangmarum Cox	?		X	
Fimbria furoni Cox	X	?	X	
Fimbria subdavidsoni (Furon)	X	X		
Glycymeris subtogoensis Furon	?	X		X
Glycymeris togoensis (Oppenheim)	X	X		

Macrocallista adabionensis (Oppenheim)	X	X	X	X
Macrocallista aurilitoralis Cox	X		X	
Macrocallista ewekoroensis, n. sp.	X			?
Macrocallista gruneri (Oppenheim)	X	X		X
Macrocallista proxima Deshayes[3]		X		X
Tellina (Elliptotellina) kouriatchyi Furon	X	X		
Trachycardium mamillatum (Furon)	X	X		
Venericardia juneri Cox	X		X	
Venericardia koerti Oppenheim	X	X		X
Venericardia tabligboensis Oppenheim	X	X		
Venericardia togoensis Oppenheim	X	X		X
CEPHALOPODA				
Deltoidonautilus togoensis Miller[2]	X	X		X

Species cited occurs also in [1]Landana, [2]Soudan, [3]Morocco.

The composition of the Ewekoro fauna is comparable with that of the Mokattam fauna. The dominant elements are species of *Solariella, Collonia* (equivalent to *Afrollonia* new genus), *Vulsella, Velates, Heligmotoma s. s.*, and species of the *Cardita-Cossmannella-Venericardia* group. The turritellids, especially *Mesalia* are also identical with development of parallel morphotypes. Many of these were considered conspecific by Oppenheim (1915), but are here regarded as the product of geographic speciation within a common stock.

The identity of the Ewekoro malacofauna with the upper Ranikot fauna of India is even more impressive. *Strepsidura kerstingi* Oppenheim, a common West African Paleocene species is virtually indistinguishable from *Strepsidura indica* Cossmann from Jhirak, India. Parallel evolutionary development of species is also demonstrable for many of the genera especially *Torquesia, Carolia, Haustator, Mesalia, Pyrazus, Pugilina* [= *Murex (Phyllonotus)* of authors], *Surculites, Eocypraea, Cypraea, Gisortia, Ampullina,* and *Tectus.*

The fact that intermediate geographical areas (*e.g.* Sokoto, Soudan) share species in common with either area (*Gisortia brevis*, Parker, 1964; Douvillé, 1920; planktonic Foraminifera, Kogbe, 1972c; ostracodes, Reyment, 1966c, 1966e) shows that free communication and exchange of fauna occurred between the West African basins and the more northerly basins of Egypt and India *via* the trans-Saharan epeiric sea during the Paleogene.

Apart from *Fimbria subdavidsoni* Furon which is comparable with *F. davidsoni* Deshayes from the Thanetian of the Paris Basin

(Farchad, 1936), the European Paleogene faunas share little in common with contemporaneous West African faunas. The common occurrence of similar-sized but different species of ?*Odostomia, Clinuropsis, Astarte, Campanile, Sassia, Arctica, Siphonalia,* and *Pseudaulicina* should be noted. These are mostly warm temperate elements which were widely dispersed during the Paleogene.

The Ewekoro fauna shares several elements in common with the trans-Atlantic faunas of the Gulf Coastal United States (Midway Stage, Harris, 1896; Gardner, 1933), the Soldado fauna of Trinidad (Maury, 1912; Rutsch, 1943) and the Maria Farinha fauna of Pernambuco, Brazil (Maury, 1912; Penna, 1965).

Significantly, *Clinuropsis diderrichi* Vincent, a common Ewekoro species, occurs also in the Soldado Rock (Rutsch, 1943), and species of the new genus, *Wendella* are known only from the Ewekoro Formation (this report) and the Midway Stage (Harris, 1896).

Apart from these, comparable species of *Rimella* (*Calyptraphorus* of authors, in part), the *Volutocorbis-Volutilithes* lineage, *Buccinorbis, Cimomia, Euspira, Cornulina,* turritellids, *Cucullaea* and *Venericardia* occur in both areas (compare, for example, *Cimomia dessauvagiei* new species, *Pseudoliva (Buccinorbis) guineensis,* new species, *Wendella nigeriensis,* new species, *Cornulina (Afrocornulina) africana,* new species and *Venericardia (Venericor) nigeriensis,* new species, with *C. vaughani* (Gardner), *P. (B.) vetusta* (Conrad), *W. globoleve* (Harris), *C. armigera* Conrad and *V. (V.) mediaplata* Gardner and Bowles respectively.

The general similarity in the fauna is probably best explained by assuming that the two land masses (West Africa and the middle Americas) were contiguous during much of the Mesozoic and so had a homogeneous fauna. As the continents drifted farther apart in Middle and Upper Cretaceous and Tertiary times, faunal divergence was the rule (Kauffman *in* Hallam, 1973, p. 372) but a certain degree of homogeneity was produced by successive introduction of Tethyan elements (Gardner, 1931; Rutsch, 1936a, 1936b; Gardner and Bowles, 1939; Hanna and Hertlein, 1939; Richards, 1946; Palmer and Richards, 1954; Palmer, 1957, 1967; Ingram, 1940), such as *Campanile, Velates, Gisortia, Wendella,* new genus, *Venericardia.* Using the best available estimates, the separation of the continents bordering the Atlantic occurred between 150 and 200 million years ago (Ramsay, 1971; Phillips and Forsyth, 1972). Inasmuch as the Gulf of Guinea area was the last to separate (Burke and others, 1971, 1972), the faunal divergence noted between parallel species in these areas during the Paleocene represents about 80 million years of evolutionary change.

TETHYAN ELEMENTS IN THE EWEKORO FAUNA

Distinct faunal elements have been associated with the incursion of the Tethyan sea and the presence of these in a fauna has generally been taken as positive indication of Tethyan affinities. The most important of these are *Nummulites, Campanile, Velates, Crommium, Gisortia, Terebellum, Eovasum, Bellatara, Carolia,* and *Lithophaga* (Davies, 1934; Palmer, 1937, 1967; Palmer and Richards, 1954; Gardner, 1931; Gardner and Bowles, 1939; Rutsch, 1936a, 1936b, 1943; Richards, 1946).

Until recently, the West African area, south of Senegal was considered a non-nummulitic facies (Davies, 1934, fig. 15) and was excluded from the areas with Tethyan influence. A strong Tethyan affinity was suggested for the area by the writer (Adegoke, 1972a, 1972b, 1973) based on the discovery of *Nummulites* in Ivory Coast (Abrard, 1955), Cameroons (Blondeau, 1966) and at Ewekoro, Nigeria (Sachs and Adegoke, 1973), as well as the presence in the Ewekoro and neighboring West African faunas of several typical Tethyan taxa including *Campanile* (Tessier, 1952; Adegoke and Dessauvagie, 1970), *Clinuropsis, Velates, Gisortia, Clavilithes, Terebellum* (including a doubtful Nigerian occurrence), *Ampullina, Crommium, Pseudocrommium, Volutilithes, Lithophaga,* and *Carolia.*

A more detailed knowledge of the vertical and horizontal distribution of the marginal Tethyan faunas of the south Atlantic area is needed for a more detailed biogeographic subdivision of the area. Neither the classically recognized biogeographic units (Tethyan, Boreal, anti-Boreal) nor the more recently proposed terminologies (Inner tropical of Hall, 1964, and South Atlantic Subprovince of Kauffman *in* Hallam, 1973) adequately depict the degree of faunal diversification in the West African Paleogene.

COMPARISON WITH EOCENE FAUNAS AND STATUS OF THE PALEOCENE

A beautifully preserved fauna consisting of about 72 species has been described from the type locality of the Ameki Formation in eastern Nigeria (Newton, 1922; Eames, 1957). This fauna is of Lutetian age (Adegoke, 1969b). An identical fauna was recorded by Reyment (1965a) from an equivalent subsurface section in Western Nigeria a few kilometers south of Ewekoro.

The Ewekoro fauna shares little in common with this Eocene fauna. Most of the diagnostic Ameki genera and subgenera which were proposed as new by Eames (1957), and many of which are known in Eocene sections in Senegal and Morocco are absent in the Ewekoro fauna. Notable among these are species of *Cyrtulotibia, Varicohilda, Bendeia, Laccinum, Bendeluta, Africosveltia, Mitrelloturris, Africarca, Rectangularca, Africofragum, Sinodiopsis, Bendemacoma.* Nautiloids which are common at Ewekoro are unknown in the Ameki Formation. The only important common forms are species of *Pseudomazzalina, Janiopsis, Buccinorbis, Hexaplex (Paziella), Kitsonia, Crepispisula,* and comparable carditids.

The Ewekoro fauna similarly shares little in common with the Eocene fauna from the Cameroons described by Oppenheim in 1904.

A comparable disparity between Eocene and Paleocene faunas is demonstrable also in Senegal (Tessier, 1952) and Morocco (Salvan, 1954). Only a few of the Paleocene species range into the Eocene. It is thus obvious that considerable evolutionary development must have taken place between these periods in West Africa.

The implications of this are particularly relevant to the problem of the status of the Paleocene. A number of workers notably Mangin (1957) and Eames (1968 and 1971, personal communication) have, in recent years, advocated the relegation of the Paleocene to the minor rank of the basal stage of the Eocene. Eames' contention is based on the fact that the Pakistan-India Paleocene faunas, especially larger Foraminifera and mollusks, are so closely related to the superjacent Eocene faunas that both should be grouped together. In his revised version of Davies' *Tertiary Faunas* (vol. 1, 1971) he assigned the Danian to the Upper Cretaceous!

Eames' views, however, are not corroborated by evidences from vertebrate paleontology (Evernden and others, 1964), micropaleontology (Berggren, 1965, 1971, 1972) and the result of the present study. Results of combined radiometric and paleontological dating (Berggren, 1969, 1972; Evernden and Evernden, 1970) show conclusively that the Paleocene Epoch has a duration of at least 11.5 million years, and is thus, almost of the same duration as many of the other Cenozoic epochs. It is also noteworthy that the differences between Paleocene and Eocene faunas are, in general, greater than those between epochs of the Neogene (Kauffman, 1973, personal communication).

One cannot but sound a note of concern at the catastrophist idea so implicit in Eames' argument. Though biostratigraphic boundaries are generally drawn at points marking the origin and extinction of taxa, the subjacent and superjacent faunas are, of necessity closely related especially wherever the stratigraphic record is almost complete, hence boundary problems. If Eames' contention were carried to its logical conclusion, the entire stratigraphic record would belong to one giant epoch!

PALEOECOLOGY

GENERAL STATEMENTS

The Ewekoro Formation is of immense paleoecological interest. It consists of a massive accumulation of coquinoidal limestone in an area where the entire pre- and post-depositional record is of detrital, terrigenous, nonfossiliferous material.

The base of the formation is sandy, it grades into the underlying, sandy Abeokuta Formation. The terrigenous content of the limestone decreases rapidly toward the top. It is separated from the overlying Akinbo Shale by a disconformable contact, indicating a major change in the depositional regime. This change was accompanied by cessation of deposition and erosion as evidenced by the intense scouring of the uppermost algal biosparite and red phosphatic biomicrite units (Pl. 3, fig. 1). The overlying Akinbo Formation is almost pure shale with thin bands of calcareous material occurring only near the base.

Several aspects of the microtexture of the Ewekoro Formation indicate deposition in the near-shore, active wave zone. These include, the well-sorted sand-size particles in the sandy biomicrosparite, the intense fragmentation and the angular nature of the allochems in the shelly biomicrite and red phosphatic biomicrite, and the high angle crossbedding (Jones and Hockey, 1964, pl. 2A) in the algal biosparite.

Many elements of the Ewekoro fauna are indicative of extremely shallow depth of deposition. These include littoral rocky shore and sublittoral dwellers such as *Anomia, Barbatia, Lithophaga, Mytilus, Calyptraea, Vermetus, Ostrea, Fissurella,* and *Hipponix* (Keen, 1963). Besides, the predominant genera in the fauna are forms which today inhabit shallow bathymetric ranges. Among them may be cited (Keen, *op. cit.*):

GENUS	RECORDED DEPTH RANGE (FM.)
Anadara	0-70
Cardita	10-100
Corbula	0-40
Glycymeris	0-200
Modiolus	0-40
Parvilucina	10-135
Pitar	15-100
Tellina	0-75
Dentalium	5-650
Olivella	0-50
Sinum	0-25
Solariella	10-600
Turritella	10-100
Bursa	10-60
Cerithiopsis	0-85
Cylichna	2-75
Odostomia	0-350

Though many of these have considerably extensive bathymetric ranges, the preponderance of shallow water, sublittoral forms suggests that the maximum depth probably did not exceed 10 fathoms. The phosphatic accumulations (Bushinski, 1964) and the abundant stranded nautiloid shells similarly indicate shallow, near-shore depths. The nautiloids and the sparse planktonic Foraminifera indicate the presence of normal ocean salinity as well as direct communication with the open sea.

Though a few of the contained genera are euryopic forms which are normally restricted to tropical latitudes today (*Anadara, Pitar, Turritella*) the bulk of Ewekoro genera indicate a warm temperate or subtropical climate. The absence of a true reef development in the formation also indicates that a cold oceanic current like the modern Benguela Current has consistently swept the West African coastline since earliest Tertiary times.

Reyment (1966d) suggested the presence of such a northward drifting current along West Africa during the Paleocene. He, however, erroneously concluded that such a current carried empty nautiloid conchs from the then known area of abundance at Cabinda to the Nigerian and Togolese shores. The writer showed (Adegoke, 1972a and this report) that nautiloids are as abundant in Ewekoro as in Cabinda and that the fauna in the former area is even more diverse. This greater diversity, the unworn nature of the Ewekoro finds and the preponderance of biostratonomically poor floaters with long body chambers (Reyment, 1958; Teichert, 1964) show conclusively that the Ewekoro nautiloids are autochthonous.

Despite the seemingly favourable ecological condition, the majority of the Ewekoro molluscs were of microscopic size and the few large forms present rarely attained the maximum size known for their group. These confirm a marginal-tropical or subtropical environment.

GASTROPOD PREDATION

Much attention has been devoted in recent years to predator-prey relationships as a major tool in ecological and paleoecological interpretation (Hayasaka, 1933; Siler, 1965; Carricker and Yochelson, 1968; Reyment, 1966f; Taylor, 1970; Adegoke and Tevesz, 1974).

Predatory boring gastropods are known to be restricted to two families, the Naticidae and the Muricidae. Representatives of both families are common in the Ewekoro fauna. Four species were identified: *Euspira togoensis* (Furon), *Sinum ewekoroensis*, n. sp., *Rapana (Nigerapana) ewekoroensis*, n. sp., and *Hexaplex (Paziella) ewekoroensis*, n. sp. It is assumed that all four species were potential borers of Ewekoro molluscs.

The predatory pattern in the Ewekoro Formation is so closely identical with that of the Ameki Formation (Eocene) of eastern Nigeria recently studied by Adegoke and Tevesz (1974) that only a summary of major conclusions is given below.

Naticids were the major predators of the Ewekoro molluscs. They outnumbered the muricids by a factor of more than 15 and were responsible for over 95 percent of the borings recorded.

In contrast to the habit of modern representatives of the group (Paine, 1963), the Ewekoro naticids preyed most frequently on gastropods rarely touching the pelecypods. The tiny gastropods seemed selectively attacked. The commonest prey were:

Afrollonia nigeriensis, n. sp. (Pl. 11, figs. 12-15)
Hexaplex (Paziella) ewekoroensis, n. sp. (Pl. 32, figs. 17, 18)
Mesalia reymenti, n. sp. (Pl. 14, fig. 20)
Mesalia salvani, n. sp. (Pl. 14, figs. 14, 15)
Pseudoliva funkeana funkeana, n. sp. (Pl. 25, figs. 8, 9, 11, 13-17)
Reymentella olaniyani, n. sp. (Pl. 15, figs. 14-17)
Solariella adedayoi, n. sp. (Pl. 12, figs. 6, 14)
Tritonidea africana, n. sp. (Pl. 24, figs. 5, 6, 8)
Volutilithes (Afrovolutilithes) oppenheimi, n. sp. (Pl. 30, fig. 25)
Volutocorbis furoni, n. sp. (Pl. 30, figs. 23, 24).

Among these, *Pseudoliva funkeana* and *Reymentella olaniyani* were the worst affected. Between 80 and 90 percent of the specimens collected were bored. A few specimens had more than one borehole.

Pelecypods were preyed upon less frequently. Among the few bored were:

Anomia cooperi, n. sp. (Pl. 35, figs. 10-15, 17, 18, 20, 22)
Barbatia (Acar), sp. aff. *putealis* Cox (Pl. 33, fig. 12)
Corbula atlantica Furon (Pl. 48, fig. 14)
Venericardia juneri Cox (Pl. 48, fig. 27)
Carditella baloguni, n. sp. (Pl. 50, fig. 2).

Among these, only *Anomia cooperi* was bored to a considerable extent by the muricids.

No selectivity for site of boring was noticed. The spire whorls appear to have been bored just as randomly as the body whorls. Similarly, there appears to be no definite correlation between prey size and predator size (judged by the diameter of the hole drilled). Small prey were sometimes attacked by relatively large predators (Pl. 15, figs. 14, 15, 17; Pl. 25, figs. 14, 15) and vice-versa (Pl. 12, figs. 24, 25; Pl. 13, fig. 6).

Coarseness of sculpture or thickness of valve were not effective deterents to boring as several thick-shelled, coarsely sculptured species were bored while many equally abundant, similar-sized, and smoother forms were not attacked (*Bittium guineense,* n. sp., Pl. 13, fig. 15; *Cerithiopsis adekunbii,* n. sp., Pl. 17, fig. 25; *C. fagadei,* n. sp., Pl. 17, fig. 26; *C. yoloyei,* n. sp., Pl. 17, fig. 30, *Tritonidea africana,* n. sp., Pl. 24, figs. 5, 6, 8).

Finally, cannibalism occurred frequently among the naticids (Pl. 21, figs. 3, 4, 7, 20).

The result of this study is similar, not only to that of the study of the Eocene of eastern Nigeria, but also to that obtained by

Taylor (1970) for an Eocene assemblage from the Paris Basin. It confirms my conclusion that two major evolutionary changes in predatory pattern have taken place since the Tertiary times: a numerical increase in the muricid population and a change in food preference among the naticids from gastropods in the Tertiary to pelecypods today.

AGE OF THE EWEKORO FORMATION

The Paleocene age first suggested for the Ewekoro Formation by Reyment (1964) has been substantiated by most subsequent workers except Fayose and Asseez (1972).

Avbovbo (1970) studied the Akisinde borehole, a Geological Survey of Nigeria water borehole drilled in 1937 at Akisinde about 10 miles SSW of Ewekoro. He recorded *Pseudohastigerina wilcoxensis, Bolivina ottaensis, Cibicides* sp. and *Lenticulina midwayensis* from a shale underlying a thick limestone at 601-610 feet, and *P. sharkriverensis* at 215-225 feet. He correlated the limestone with the nearby Ewekoro Formation and assigned an Eocene age to it. Fayose and Asseez (*op. cit.*) accepted Avbovbo's conclusions with little modification.

Several lines of evidence contradict their age assignment. These are briefly discussed below.

1. The descriptive log of the Akisinde borehole compiled by the Geological Survey of Nigeria shows that no stratigraphic sample was recovered between the interval 601-610 feet, thus throwing into doubt the true stratigraphic position of the *Pseudohastigerina wilcoxensis*-bearing sample examined by Avbovbo, Fayose and Asseez. The log shows further that caving occurred frequently especially in the latter part of the drilling. It is notable that none of the fossils identified from that horizon has been found at adjacent stratigraphic horizons in the same borehole or in the microfaunally much richer section exposed in the Ewekoro quarry.

2. Several typical Paleocene planktonic Foraminifera were recorded from the quarry section by Reyment (*in* Jones and Hockey, 1964) and Ogbe (1972) (see Fauna). These include *Globigerina triloculinoides, Globorotalia pseudobulloides, G. acuta, G. velascoensis,* and *G. varianta.* Besides, the *Nummulites, N. ewekoroensis,* recorded by Sachs and Adegoke (1973) is the primitive variation typically found in the Paleocene.

3. Thirty-one species of ostracodes recovered from the Ewekoro quarry were examined by Dr. M. Ebi Omatsola at the Paleontological Institute, Uppsala, Sweden (see Fauna). Most of them belong to species earlier recorded by Apostolescu (1961) and Reyment 1963, 1966c) from Paleocene horizons in West Africa. Omatsola concluded (1970, personal communication) that they indicate an upper Paleocene age.

4. Kogbe (1972b) examined the algae preserved in the Ewekoro Formation. He similarly concluded that they are mostly Paleocene forms.

5. The macrofauna described here include a large number of taxa typically found in Paleocene strata in many parts of the world. Details are given above under Affinities of the Ewekoro Fauna. A summary is presented below.

The minute echinoid *Togocyamus seefriedi* Oppenheim (Roman and Gorodiski, 1959; Durham *in* Moore, R.C., 1966; Eames *in* Davies, 1971 ed.) and the gastropod *Clinuropsis diderrichi* Vincent (Rutsch, 1943; Furon, 1949) are now universally accepted as Paleocene index species. *Tornatellaea (Ravniella) africana* Furon, a common Ewekoro gastropod, belongs to a subgenus presently unknown outside the lower Paleocene (Rosenkrantz, 1970).

Additionally, several Ewekoro species are almost identical with species from well-dated Paleocene horizons such as the Ranikot beds of India, the Mokattam beds of Egypt, the Midway Stage of the Gulf Coastal region of the United States and Texas, the Soldado Rock of Trinidad, and the Maria Farinha beds of Pernambuco, Brazil.

6. Finally, glauconites from two horizons unconformably overlying the Ewekoro Formation (Text-fig. 6) were dated radiometrically by the B.R.G.M. Laboratories, Orleans, France. The samples yielded an average date of 54.45 ± 2.7 million years (Adegoke and others, 1972). This age corresponds to the Paleocene-Eocene transition of Berggren (1969, 1972). Ogbe (1970, 1972), in his biostratigraphical study of the formation using Foraminifera independently, placed the Paleocene-Eocene boundary at approximately the same level. Berggren (1972) reassessed Fayose and Asseez's faunal evidence and accepted the radiometric ages as conclusive proof of the Paleocene age of the Ewekoro Formation.

SYSTEMATIC PALEONTOLOGY

TAXONOMIC PROCEDURE

The writer's concept of the species, an essentially neontological one, was reviewed briefly in an earlier major taxonomic-biostratigraphic study (Adegoke, 1969a). The same procedure was adopted in this study.

New species were described when populations or representatives of them have several distinct characters which they do not share in common with other closely similar populations. New subspecies were based on fewer, less significant characters. Both vertical and geographic subspecies are recognized. For example, *Clinuropsis diderrichi* Vincent *nigeriensis* Adegoke, new subspecies, and the taxon recorded from Trinidad by Rutsch (1943) are considered as geographic variants of the typical subspecies from Landana, Congo. Where two subspecies of the same taxon are described from the Ewekoro material, (*e.g. Pseudoliva funkeana funkeana* and *P. funkeana ornata*), it is assumed that they represent lateral subspecies resulting from niche partitioning or vertical subspecies even though the difficulty of collecting stratigraphic samples makes verification impossible.

Supraspecific classification of the Mollusca especially at the generic level presented considerable difficulties.

The status of the genus as a basic concept in paleontology was reviewed in detail by the symposium of the North American Paleontological Convention (Part C, 1969). The results of the discussion show clearly that the generic concept varies widely not only from one worker to another but also depending on the group of fossils studied.

Among the Mollusca, there are many generic names in the literature that are far from adequately substantiated. Many of these were proposed by authors without due consideration for the overlap in morphological characters between closely related supraspecific groups. There is also, additionally, the growing trend to oversplit by many so-called extreme specialists. Though there are a few advantages — knowledge of "many new secrets of morphology and evolution" (Cooper, 1969) and utility in local stratigraphy — to be derived from such taxonic refinements, the disadvantages are also immense. Genera tend to be of restricted distribution and are difficult to recognize even for reasonably well-trained general paleontologists.

One of the unhappy results is the growing and often bewildering listing of synonymies that accompany most recent taxonomic works.

One of the major factors enhancing the erection of many invalid genera is the relatively small size of samples available to many workers and the general inadequacy of our knowledge of the fossil record. When a sample is small, the limits of observable variability is also small. "Genera" are consequently easy to delimit. When, however, critical and reasonably adequate samples become available (as in the present study), overlaps between taxonomic characters of many previously defined genera assume immense proportions and boundaries between genera become fuzzy and difficult to define.

Several examples of such taxonomic impassé are discussed under appropriate genera throughout this study. Attention is drawn particularly to the treatment of turritellids, *Pseudomalaxis, Rimella, Sycostoma, Strepsidura, Pseudoliva, Heligmotoma,* turrids, *Volutilithes, Ostrea,* and *Venericardia.* The latter represents perhaps the best example of taxonomic confusion in molluscan literature.

An approach similar in essential details to the polythetic treatment of Boardman, Cheetham and Cooke (1969) was independently applied by the writer. Generic differentiation was based on a series of characters which are shared in common by a large proportion of species belonging to the genus group. Within the broad genus group thus recognized, subgenera are delineated on the basis of different combinations of some of these diagnostic characters. This approach enabled me to differentiate discrete subgroups which share some of the significant characters in common with other closely related groups.

The treatment of species of the genus *Heligmotoma* serves to illustrate my approach.

The name *Heligmotoma* was proposed as a subgeneric name by Mayer-Eymar in 1895 for large, smooth shells with well-developed mamelon and deep spiral sinus. He recognized three distinct "varieties" and assigned the subgenus to *Melongena.* The taxon has been accorded generic status by most subsequent workers.

Douvillé (1920) erected the genus *Heligmotenia* for similar-sized, but poorly preserved Soudan and Senegalese material which differed from typical *Heligmotoma* only in the possession of three columellar plications. It had, however, a depressed spiral band below the body whorl shoulder — a feature which it shared in common with the *bicarinata* "variety" of Mayer-Eymar's taxon.

Three new species were collected from the Ewekoro quarry in this study. They show admirably the plastic nature of the characters used in defining the two preceding genera. The largest taxon, *H. nigeriensis* is smoothly rounded, with fairly deep spiral sinuses, lacking columellar plication. It is thus referrable to *Heligmotoma s. s.* The two other species are smaller, with typical *Heligmotoma*-like body whorl but having shallow spiral sinuses and resembling *Heligmotenia* in possessing columellar plications. They however, lacked the depressed peripheral band of the latter and bear, in addition, two uneven oblique parietal ridges — features not here-to-fore observed in the group.

Because of the apparent demonstrable plasticity, the new forms are not proposed as new genera. Instead, the oldest generic name *Heligmotoma* is applied to the genus group; Douvillé's taxon and the two Ewekoro species (described as *Douvilletoma*) are accorded subgeneric status only.

A similar argument was advanced for retaining the new subgenus *Eamesidura* in the genus *Strepsidura*.

The major advantages of this approach are that variations in combinations of diagnostic taxonomic features are given due weight in the subgeneric designations and generic affinities are not unduely obscured by the indiscriminate usage of different generic names.

NOMENCLATURAL SIGNS AND SYMBOLS

The usage of nomenclatural signs and symbols in this study follows that of my earlier work (Adegoke, 1969a, p. 84): "aff" indicates that the identified taxon is morphologically comparable and closely related genetically to, but is probably distinct from, the species to which it is compared; "cf" indicates that the taxon is most closely related to, and is compared with the species cited.

Doubtful identifications follow the usage proposed by Stewart (1926, p. 306):

(?) placed after a generic name or between generic and specific names indicates that the correctness of the generic assignment is doubtful.

(?) placed after a specific name indicates that only the specific assignment is doubtful.

(?) placed in front of the generic name indicates that the correctness of both generic and specific identification is doubtful.

When a generic name is quoted (*e.g.* "*Corbicula*") it indicates that common practise is being followed although there are unresolved questions suggesting that this usage is incorrect.

REPOSITORY

The type and illustrated specimens are kept in the University of Ife Museum of Geology, Nigeria (UIMG), the United States National Museum of Natural History (USNM). Paratypes are in Paleontological Research Institution, Ithaca, New York.

Phylum ECHINODERMATA
Class ECHINOIDEA Leske, 1778
Superorder GNATHOSTOMATA Zittel, 1879
Order CLYPEASTEROIDA A. Agassiz, 1872
Suborder LAGANINA Mortensen, 1948
Family **FIBULARIIDAE** Gray, 1855
Genus **TOGOCYAMUS** Oppenheim, 1915

Togocyamus seefriedi Oppenheim — Pl. 4, figs. 1-12, 15-16

Echinocyamus (Togocyamus) Seefriedi Oppenheim, 1915, p. 20, pl. 1, figs. 10-13.
Echinocyamus seefriedi Oppenheim, Lambert and Thiery, 1925, p. 576.
Togocyamus Seefriedi Oppenheim, Furon, 1948, p. 97, pl. 8, figs. 1; Mortensen, 1948, p. 228, text-fig. 134; Roman and Gorodiski, 1959, p. 50, pl. 3, figs. 16-19; Durham, 1966, p. 472; Adegoke, 1972a, pl. 3, figs. 1, 2.
Fibularia (Eoscutum) seefriedi (Oppenheim), Cox, 1952, p. 35, pl. 5, figs. 17-20; Chabaglian, 1959, pp. 140, 142, 146.

Diagnosis. — Species characterized by small, low, compressed test, long and broad petals with non-conjugate pores.

Material. — Almost 2,000 specimens collected from Ewekoro quarry, description and quantitative study based on 30 specimens selected to represent various stages of growth.

Shape. — Test 2.87-5.00 mm long with mean of 3.99 mm, greatest width slightly posterior of apical system. Width varying from 73-82 percent of length with mean of 77.42 percent (standard deviation = 0.0046, coefficient of variation = 3.245, number = 30); greatest height anterior to apical system, height varies between 1.20-2.05 mm, averaging between 36 to 50 percent of length with a mean of 40.86 percent (standard deviation = 0.0366, coefficient of variation = 8.97, number = 30); adapical surface gently concave to almost flat; petals and apical system flush with the surface, marginal outline egg-shaped, narrow and sub-acutely pointed anteriorly, broadly rounded posteriorly. Periproct flush, peristome depressed around the opening; adoral surface convex.

Apical system. — Slightly anterior of midline, distance from anterior margin of test to anterior genital pores varies from 1.10-2.02 mm with mean of 1.56 mm, 35 to 44 percent of length with mean of 38.83 percent (standard deviation = 0.0239, coefficient of variation = 6.15, number 28); width of apical system as measured across posterior genital pores 8 to 13 percent of length with mean of 10.90 percent (standard deviation = 0.0193, coefficient of variation = 17.73, number = 28). Genital pores are subcircular to slightly regular in outline and are arranged in subtrapezoid with anterior pair closer and more eccentric than posterior pair (Pl. 4, fig. 16).

Ambulacra. — Petals short and broad, and except for III extend less than ⅔ distance to the edge; length variable with III longer than II longer than I; length of petal III varying from 16 to 32 percent of length of test with mean of 27.55 percent; width varying from 14 to 20 percent of length of test with mean of 16.86 percent; length of petal II varying from 13-23 percent of length with mean of 19.50 percent, width varying from 11-17 percent of length with mean of 14.24 percent; length of petal I varying from 11-22 percent of length with mean of 16 percent, width varying from 10 to 16 percent of length with mean of 12.49 percent; greatest width of petals near distal end.

Interporiferous zones expanding distally, slightly contracted at the distal end; pores non-conjugate (see also Roman and Gorodiski, 1959, p. 51), opening circular, smallest specimen 2.87 mm long with 3 pore-pairs in single poriferous zone in petal I, 4 in petal II and 5 in petal III, largest specimen 5.02 mm long with 7 in petal I, 8 in petal II and 9 in petal III; average of 5.17 porepairs in all measured specimens in petal I, 6.27 in petal II and 7.93 in petal III with a mean of 1.29 porepairs in single poriferous zone for each mm of length of test in petal I, 1.57 in petal II and 1.99 in petal III. Single rows of diverging tiny pores in ambulacra beyond petals (Pl. 4, figs. 1, 3).

Peristome. — Peristome 0.70 to 1.00 mm wide with a mean of 0.88 mm, located slightly posterior of midpoint, circular (Pl. 4, figs. 7-10); height varying from 17 to 29 percent of length with mean of 22.35 percent (standard deviation = 0.0241, coefficient of variation = 10.79, number = 30).

Periproct. — Width, 2.3 to 4.2 mm with a mean of 3.22 mm, situated near the posterior margin of the apical surface; distance from anterior margin is 76 to 87 percent of length with mean of 80.56 percent (standard deviation = 0.0310, coefficient of variation = 3.85, number = 30), subcircular, slightly higher than wide, opening about ¼ width of peristome.

Internal structure. — Ten subequal internal partitions present (Cox, 1952, pl. 5, fig. 20).

Exterior sculpture. — Plates clearly visible in only a few well-preserved specimens. Exterior surface sculptured by relatively large spine bases with deep depressions and slightly eccentric bosses (Pl. 4), spine bases not arranged in any definite pattern.

Types. — Holotype is kept in the Central Geological Office for German Territories (Geologischen Zentralstelle für die Deutschen Schutzgebiete) in Berlin (Oppenheim, 1915), Hypotypes, UIMG Nos. 139, 160-163; USNM Nos. 174756-174759.

Remarks. — Though this species has been recorded by a fair number of workers, it has not been fully described. This is primarily that most earlier workers had only a few poorly preserved specimens for study. The best description to date was by Roman and Gorodiski (1959) who included some quantitative data about the species and described a second species, *T. alloiteaui* from the Paleocene of Senegal.

The collection of over 2,000 specimens from the Ewekoro Formation in this study permitted a more comprehensive, quantitative computerized study of variation within the species.

The illustrations of Oppenheim (1915), Cox (1952), as well as the data of Roman and Gorodiski, show that the specimens recorded earlier from Togo, Ghana, and Senegal fall within the limits of the variation of the species as defined here on the basis of the more abundant Nigerian material.

T. alloiteaui Roman and Gorodiski differs from *T. seefriedi* Oppenheim by its narrower width (68% of length), its much higher test (59% of length), the conjugate pore (Roman and Gorodiski, 1959, p. 52) and the more distally located periproct.

Superorder ATELOSTOMATA Zittel, 1879
Order CASSIDULOIDA Claus, 1880

Family **CASSIDULIDAE** Agassiz and Desor, 1847
Genus **CASSIDULUS** Lamarck, 1801

Cassidulus kieri Adegoke, new species Pl. 5, figs. 1-14

Cassidulus, new species, Adegoke, 1972a, pl. 3, figs. 6, 7.

Diagnosis. — Species characterized by relatively high test, narrow, elongate petals with conjugate pores, pentagonal peristome with subparallel phyllodes and weakly developed bourrelets.

Material. — Thirty-two well-preserved, mostly complete specimens. Description and quantitative study based on 21 specimens selected to represent different growth classes.

Shape. — Test large, ovately quadrangular; length varies from 9.15-18.86 mm with a mean of 15.02 mm; width varies from 8.31 to 16.14 mm with a mean of 12.76 mm; width 79-91 percent of length (mean 85 percent) with greatest diameter about midway between apical system and posterior margin. Test high, greatest height occurs posterior to the apical system, height 52 to 61 percent of length with mean of 56.5 percent. Anterior margin subacutely pointed to broadly rounded, posterior margin subtruncated, dropping steeply from the highest point to the ventral margin. Petals distinct, flush with the surface.

Apical system. — Located anterior to the midline with four narrow genital pores trapezoidally arranged (Pl. 5, figs. 1, 11), anterior pair closer together than posterior.

Petals. — Narrow and elongate, slightly closing towards apical end; width varies from 9.2 to 9.8 percent of length of test. Petals V and I longer than others, with petal III longer than II and IV. Pores conjugate (Pl. 5, figs. 1-4, 11-14), posterior rows of porepairs more oblique and more arcuate than anterior rows in all but petal III, where it is more or less symmetrical.

Specimen 9.15 mm long with 12 porepairs in single poriferous zone in petal III, 12 in petal II and 13 in petal I. Specimen 18.18

mm long with 19 porepairs in single poriferous zone in petal III, 21 in petal II and 23 in petal I. Mean of porepairs in single poriferous zone of all measured specimens 20 in petals III and II and 23.46 in petal I. Petal III is 26 percent of length (standard deviation = 0.0010, coefficient of variation = 11.97, number =15), petal II is 23.62 percent of length and petal I is 30.80 percent of length.

Periproct. — Submarginal (Pl. 5, figs. 1-4), situated near the apical edge on the posterior truncated face, with a broad trough extending from ventral margin of anal opening to the oral margin; opening longer than wide (Pl. 5, fig. 9).

Peristome. — Slightly anterior of center, pentagonal (Pl. 5, fig. 5) to broadly subovate (Pl. 5, fig. 8), with weak to moderately swollen rim (bourrelet), much broader than high; peristome height 17.63 percent of length of test (standard deviation = 0.0192, coefficient of variation = 10.90, number = 18).

Floscelle. — Bourrelet weakly developed (Pl. 5, figs. 5, 8). Mouth surrounded by a floscelle consisting of five moderately broad phyllodes which are subparallel and slightly constricted adorally. In specimen 15.82 mm long, 8 pore pairs present in phyllode III, 7 in II and 8 in I; 7-10 pores present in each inner series.

Tuberculation. — Tubercles small, uniformly developed and subevenly distributed over entire test; narrow naked zone occurs orally in the middle of interambulacrum V.

Aberrant specimen. — A single aberrant specimen with four petals was collected (Pl. 5, figs. 12-14). Compared with the mean of normal individuals, it was relatively larger (length 18.57 mm, width 15.25 mm) and higher (height 10.20 mm). The aborted petal is Petal I (Pl. 5, fig. 14). The apical system is more anteriorly located and the petals wider, the diagonal grooves linking the conjugate pores are more prominent. The periproct is also less porous than in normal individuals (compare figure 13 with 11 on Pl. 5).

Types. — Holotype, UIMG No. 145; paratypes, UIMG Nos. 164-165, USNM Nos. 174760-174762.

Remarks. — The new species differs from *Cassidulus senni* Kier (1966, p. 8) by its much larger size, more posteriorly located anus, more inflated test, and the subparallel phyllodes which bear more pores in the inner series.

The Nigerian species superficially resembles *Cassidulus mestieri*

Kier (1966, p. 10) but the phyllodes are narrower and more parallel, and the anus is located relatively higher on the aboral surface.

The new species is named in honor of Dr. Porter M. Kier, Smithsonian Institution, Washington, D.C.

Order SPATANGOIDA Claus, 1876

Suborder HEMIASTERINA A. G. Fischer, 1966

Family **HEMIASTERIDAE** Clark, 1917

Genus UNCERTAIN

Indeterminate spatangoid Pl. 4, fig. 17

Material. — A single incomplete specimen.

Illustrated specimen. — USNM No. 174763.

Remarks. — A small fragment of an indeterminate spatangoid was collected from the Ewekoro quarry. The specimen shows well-developed food grooves and a system of even and closely packed tubercles. Despite its excellent preservation the collected specimen measuring approximately 12 mm across is too fragmentary for generic identification. It is the first spatangoid recorded from the Paleocene of West Africa.

Order PHYMOSOMATOIDA Mortensen, 1904

Family **PHYMOSOMATIDAE** Pomel, 1883

Genus **THYLECHINUS** Pomel, 1883

Subgenus ?**THYLECHINUS** sensu stricto

Thylechinus (?Thylechinus) tessieri Adegoke, new species Pl. 4, figs. 18-21

Diagnosis. — Species characterized by minute, compressed test, wide peristome and periproct and two grades of tubercles.

Material. — The new species is represented by a single specimen.

Description. — Test small, compressed; diameter almost twice the height of the test. Peristome wide, about 57 percent of diameter. Apex flattened, with a centrally located periproct. Periproct wide, about 43 percent of diameter. Details of plate arrangement not clearly visible. Test ornamented by two major grades of tubercles which form rather indistinct rows. Two rows of tubercles occur in each interambulacral area and two less distinct rows of ambulacral tubercles occupy the elevated area between adjacent rows of pore pairs. The major interambulacral tubercles are centrally located on the plates, they alternate in position in adjacent rows and are surrounded by several secondary tubercles. At least 14 pore pairs were counted in each poriferous zone. Pores are non-conjugate and each pair is located on a subordinate granule.

Type. — Holotype, UIMG No. 166.

Dimensions. — Diameter of test 3.5 mm; height 2.1 mm; diameter of peristome 2.0 mm; diameter of periproct 1.5 mm.

Remarks. — The new species is characterized by its extremely minute test. It is smaller, less compressed, with a wider peristome and heavier tubercles than *Thylechinus sornayi* Tessier from the Paleocene of Marigot de Balling, Senegal. It is also much smaller, less compressed and with fewer major tubercles than *T. gueoulensis* Tessier from the Lutetian of Kaneme, Senegal.

The new species is named in honor of Dr. F. Tessier.

Indeterminate echinoid Pl. 9, figs. 3, 4

Remarks. — A small fragment measuring almost 6 mm of an indeterminate echinoid was collected from the Ewekoro quarry. The fragment was moderately flat and thin-walled. The surface is covered by closely packed tubercles of varying sizes, larger ones (primary) being concentrated on one side (Pl. 9, fig. 3).

Illustrated specimen. — UIMG No. 167.

Indeterminate echinoid spines Pl. 4, figs. 13, 14

Remarks. — Two echinoid spines, one of which was reasonably worn, were collected from Ewekoro quarry. The specimen illustrated in Plate 4, figure 13 bears fine longitudinal ridges and still retains the condyle and base in a fine state of preservation. It may belong to the indeterminate species described above.

The specimen illustrated in Plate 4, figure 14 by contrast is worn. Its large size and the shape suggest that it may belong to a different species from the former.

The general features of both spines is suggestive of those of cidaroids.

Illustrated specimens. — UIMG Nos. 168, 169.

Class CRINOIDEA Miller, 1821

Indeterminate (?) crinoid Pl. 10, fig. 10

Remarks. — A small fragment of a probable crinoid stem was recovered from the Ewekoro material. The specimen bears on the exterior several fine, closely spaced growth marks and is encrusted by a number of calcareous tube-secreting epibionts. Intense re-crystallization makes unqualified identification impossible.

Illustrated specimen. — UIMG No. 178.

Phylum ARTHROPODA

Class CRUSTACEA

Family **CALLIANASSIDAE** Dana, 1852

Genus **CALLIANASSA** Leach, 1814

Callianassa seefriedi von Ammon Pl. 6, figs. 3-7

Callianassa seefriedi von Ammon, 1906, p. 470, fig. 16; Oppenheim, 1915, p. 64, pl. 5, figs. 7a-c; Furon, 1948, p. 112. Cox, 1952, p. 52, pl. 5, figs. 15, 16. ?*Callianassa* sp. Tessier, 1952, p. 315, pl. 39, figs. 16, 18, 19.

Types. — Hypotypes, UIMG Nos. 183-185, USNM Nos. 174768, 174769; PRI Nos. 29761, 29762, 29763.

Remarks. — This species has been recorded from several West African localities from fragments of ambulatory appendages. It is an important component of the Ewekoro fauna.

Phylum MOLLUSCA

Class SCAPHOPODA Bronn, 1862

Family **DENTALIIDAE** Gray, 1834

Genus **DENTALIUM** Linné, 1758

Subgenus **LAEVIDENTALIUM** Cossmann, 1888

Dentalium (Laevidentalium) guineense Adegoke, new species Pl. 5, figs. 15-18

Description. — Shell small, thin-walled, with circular outline throughout. Shell curved appreciably, point of maximum curvature occurs near the middle of the shell. Exterior surface roughly sculptured by annular growth marks. Two grades of growth rugae are discernible: coarser bands about 2-4 mm apart which give a noded appearance to the shells and finer, closer-packed growth marks. Growth lines are approximately perpendicular to the axis of the shell. Apical end about half diameter of anterior end.

Material. — Thirty nearly complete specimens.

Types. — Holotype, UIMG No. 176; paratypes, UIMG No. 177, USNM Nos. 174763, 174764; PRI Nos. 29764-29769.

Dimensions (mm). —

	length	anterior diameter	apical diameter
UIMG 176	18.06	1.45	0.82
UIMG 177	12.82	1.50	1.10
USNM 174763	11.50	1.40	0.88
USNM 174764	18.55	1.75	0.95

Remarks. — The new species is characterized by its small size, the prominently curved shell and the rugose sculpture produced by the growth marks. It is the most abundant scaphopod present in the Ewekoro fauna. It is represented in my collection by about 30 mostly complete specimens.

The new species is named for the Gulf of Guinea.

Dentalium (Laevidentalium) nigeriense Adegoke, new species
Pl. 7, figs. 5-10

Description. — Shell small to medium-sized, moderately thick-walled, short and only slightly curved; outline circular throughout. Shell widens rapidly from narrow apical end to a fairly wide anterior end. Exterior surface with a smooth glossy finish, faintly marked by irregularly prominent growth striae which are oriented obliquely to the shell axis.

Material. — Twenty-two fragmentary specimens.

Types. — Holotype, UIMG No. 179; paratypes, UIMG Nos. 180, 181, USNM Nos. 174765, 174766.

Dimensions (mm). —

	length	anterior diameter	apical diameter
UIMG 179	21.90	3.00	1.52
UIMG 180	5.70	0.80	0.50
UIMG 181	13.90	2.95	2.21
USNM 174765	9.00	2.00	1.80
USNM 174766	7.90	2.60	2.30

Remarks. — This species is characterized by its slightly curved shell, the rapid taper and the smoothly textured exterior surface.

These features distinguish it readily from the narrower and more prominently curved *D. (Laevidentalium) guineense*, new species.

The new species is comparable with the indeterminate *Dentalium* recorded by Vincent (1930b, pl. 3) from the Tuffeau de Ciply.

The new species is named after Nigeria.

Subgenus **ANTALIS** H. and A. Adams, 1854

Dentalium (Antalis) ewekoroense Adegoke, new species

Pl. 6, figs. 10, 11

Description. — Shell small, conical, more or less straight and only gently tapered. Maximum curvature occurs near anterior end. Shell is beautifully sculptured by narrow, faintly elevated closely spaced axial threads regularly intersected by growth rings which are slightly oblique to the shell axis. Both axial and annular ribs intersect to produce a fine reticulate sculpture.

Material. — Three incomplete specimens.

Types. — Holotype, UIMG No. 182; paratype, USNM No. 174767.

Dimensions (mm). —

	length	anterior diameter	apical diameter
UIMG 182	7.44	1.10	0.80
USNM 174767	6.80	1.12	0.64

Remarks. — This fine species is represented by three incomplete specimens. It is characterized by its extremely fine reticulate sculpture. This sculptural pattern resembles that of *D. (Entaliopsis) aequale* Deshayes and *D. (Entaliopsis) grande* Deshayes from the Paris Basin. The new species differs, however, by its smaller size and the straighter shell.

Class GASTROPODA Cuvier, 1797

Subclass PROSOBRANCHIA Milne Edwards, 1848

Order ARCHAEOGASTROPODA Thiele, 1925

Superfamily **FISSURELLACEA** Fleming, 1822

Family **FISSURELLIDAE** Fleming, 1822

Subfamily **FISSURELLINAE** Fleming, 1822

Genus **FISSURELLA** Bruguiere, 1789

Fissurella nigeriensis Adegoke, new species Pl. 11, figs. 1, 2

Description. — Shell small, asymmetrical cone with a suboval ventral outline and a posteriorly located apical perforation. Shell sculptured by narrow, prominent, equidistant radial ribs the interspaces of which are occupied by three less prominent radial ribs of which the middle is more prominent. Radial ribs intersected by prominent and closely spaced concentric threads which are less prominent than the secondary radial ribs. Detail of the interior of valve is unknown. The new species is represented by a single specimen.

Material. — A single, almost complete specimen.

Type. — Holotype, UIMG No. 186.

Dimensions. — Length (posterior incomplete) 5.5 mm; width 3.2 mm; height 2.15 mm.

Remarks. — The new species is smaller than *Fissurella* sp. figured by Tessier (1952, pl. 29, fig. 26) from the Paleocene of Marigot de Balling, Senegal. It differs further in having three secondary radials between major ones whereas prominent and faint radials alternate in the Senegalese species.

The prominent sculpture distinguishes the new species from the smooth *Fissurella nuda* recorded from the upper Mokattam beds of Egypt (Oppenheim, 1906) and the Lutetian of Maroc (Salvan, 1954).

Fissurella feddeni Cossmann and Pissarro (1909) from the Ranikot of India is higher and has a steeper sloping shell on which heavy and faint radial ribs alternate.

This record and that of Tessier (1952) from Senegal show that the Fissurellinae had their origin as far back as the Paleocene in West Africa (Keen *in* Moore, 1960, p. 1230).

Superfamily **NERITACEA** Rafinesque, 1815

Family **NERITIDAE** Rafinesque, 1815

Subfamily **NERITINAE** Rafinesque, 1815

Genus **VELATES** Montfort, 1810

Velates nigeriensis Adegoke, new species Pl. 11, figs. 3-7

Velates, n. sp., Adegoke, 1972a, pl. 3, fig. 3.

Description. — Shell large, heavy, thick-walled, with oval ventral outline. Apex asymmetrically located in the posterior fifth of the shell. Spire largely concealed (Pl. 11, fig. 3), located about 10 mm below the highest point in the apical region. Anterior rim of shell heavy and broadly rounded. Base flat, bearing a heavy callosity posteriorly, surface is prominently elevated above the inner lip platform. Inner lip margin bears six unequal, heavy, blunt teeth of which the outermost is the most prominent. Early whorls sculptured by five prominent rows of spiral nodes (Pl. 11, figs. 3, 4) of which the most apical is the most prominent. Spines attain maximum prominence at about 2½ whorls beyond which they disappear abruptly leaving only faintly discernible broad ridges that continue to the anterior margin of the shell. Exterior of shell ornamented by numerous fine wavy growth lines and occasional abruptly depressed growth lines.

Material. — Six well-preserved specimens.

Types. — Holotype, USNM No. 174740, paratypes, UIMG Nos. 141, 187.

Dimensions (mm). —

	length		maximum diameter	height
USNM 174740	67.2		56.1	43.1
UIMG 141	62.7	(incom-	62.1	42.2
UIMG 187	69.7	plete)	52.7	38.5

Remarks. — This species closely resembles *Velates* species indet. reported from the Palocene of Marigot de Balling, Senegal, by Tessier (1952) in size, shell outline, asymmetry of the apex, and the heavy basal callus. The Senegalese species is smaller, relatively higher and with a shorter, more steeply inclined anterior.

Velates nigeriensis, new species is also comparable in size with the all-inclusive Eocene species, *V. schmideli* Chemnitz (= *V. schmideliana* Chemnitz of authors) which has been reported from Jamaica (Trechmann, 1923), the Mokattam of Egypt (Oppenheim, 1906), Senegal (Tessier, 1952), Soudan (Douvillé, 1920; Furon, 1935), Paris Basin and other parts of Europe (Cossmann and Pissarro, 1910-1913). It differs, by its more rugose and nodose exterior, the more prominent basal callus, indistinctness of the lateral furrow (compare with Trechmann, 1923, pl. 15, fig. 3) and the heavier denticulation of the inner lip margin. According to Richards and Palmer (1953) some Jamaican specimens have no teeth preserved.

The holotype was collected by Dr. Barry Pass.

Suborder TROCHINA Cox and Knight, 1960

Superfamily **TROCHACEA** Rafinesque, 1815

Family **TROCHIDAE** Rafinesque, 1815

Subfamily **TROCHINAE** Rafinesque, 1815

Genus **TECTUS** Montfort, 1810

Tectus africanus Adegoke, new species Pl. 11, figs. 8, 9

Description. — Shell medium-sized, trochiform, with high, moderately acute, uniformly tapered spire of about eight whorls. Spire and body whorls low with diameter more than three times height. Sutures distinct, slightly wavy on younger whorls. Whorl side straight, ornamented by moderately wide axial ridges separated by U-shaped interspaces almost as wide as the ridges. Axial ridges slightly oblique, not perfectly continuous from whorl to whorl. About 17 axial ribs present on the body whorl. Spiral sculpture weak and poorly preserved, consists of three broad spirals which form weak nodes at the intersection with axial ribs. Base flat, with a weakly elevated submarginal ridge and a shallow depression near the inner lip margin. Columella and outer lip poorly preserved; aperture low, trigonal to subquadrate in outline.

Material. — One slightly worn specimen.

Type. — Holotype, UIMG No. 188

Dimensions. — Height 36.20 mm; maximum diameter of body 25.38 mm; minimum diameter of body whorl 24.65 mm.

Remarks. — This species is the first recorded *Tectus* from the West African Tertiary strata.

The high, acute spire, and the prominent axial sculpture distinguishes the new species from most previously described Tertiary species (Vincent, 1930b, pl. 1, fig. 4; White, 1887, pl. 10, figs. 8, 11, 12; Cossmann, 1913, pl. 2, figs. 15-34; Cossmann and Pissarro, 1910-

1913, pl. 3). The best comparisons are with *Trochus (Tectus) morgani* Cossmann and Pissarro (1904-1906, pl. 23, figs. 16, 17) which differs by the virtual absence of axial ornamentation; and *Trochus (Tectus) crenularis* Lamarck (Cossmann and Pissarro, 1910-1913, pl. 3, fig. 20-6), which has a more rugose shell and shorter, more spinelike axial sculpture which is suppressed on the adapical half of each whorl.

Family **TURBINIDAE** Rafinesque, 1915
Subfamily **COLLONIINAE** Cossmann, 1916
Genus **AFROLLONIA** Adegoke, new genus

Diagnosis. — Shell small, with moderately high spire and a small, smooth bulbous protoconch. Spiral whorls inflated and gently convex; body whorl rounded and relatively large. Whorls ornamented by fine revolving spirals a few of which occasionally become prominently elevated. Umbilicus moderately wide and deep, with a semilunar exterior outline and a turbinate, funnel-like outer chamber leading into a cylindrical inner passage separated from the former by a spiral ridge. Umbilical rim coarsely noded.

Type species. — *Afrollonia nigeriensis* Adegoke, new species.

Remarks. — The new genus *Afrollonia* is proposed here to accommodate some African Colloniinae characterized by a high spire and high body whorl, with noded or unnoded spirals, and a deep umbilicus with a semilunar outer chamber. The following species are referred to the new genus: *?Collonia grandis* Oppenheim (1906, p. 218, pl. 20, figs. 12-12b) from the Mokattam beds of Egypt; *Collonia* cf. *grandis* Oppenheim (1915) (= *Afrollonia togoensis* Adegoke, new species), from Togo and Nigeria, and the new species *A. angustiumbilicata* and *A. nigeriensis* here recorded from Ewekoro, Nigeria.

The new genus may be readily distinguished from *Collonia* Gray, 1850 by its less sturdy shell and the intense spiral sculpturing. It also resembles *Otollonia* Woodring (1928) but differs in having a semilunar umbilical outline, a less prominently elevated and finer-noded umbilical rim and largely unnoded spiral ribs.

Afrollonia nigeriensis Adegoke, new species — Pl. 11, figs. 10-15

Description. — Shell small, thin-walled. Spire moderately high, consists of 3¼ to 4 rounded whorls which are angulated medianly and ornamented by fine revolving threads. About 12 threads present on the penultimate whorl. Body whorl inflated, much wider than penultimate whorl, ornamented by several fine and three prominent ribs, the latter produce marked angulation of the upper, the middle and lower third of the whorl. Ten fine threads occur between the suture and the first prominent rib, four each between the other major ribs and 12 on the base. Umbilicus narrow, funnel-shaped, with a semilunar outer chamber separated from the inner chamber by a heavy spiral. Growth lines oblique. Aperture relatively large, subrounded.

Material. — Over 50 well-preserved specimens.

Types. — Holotype, UIMG No. 189; paratypes, UIMG Nos. 190-191; USNM Nos. 174741-174743.

Dimensions (mm). —

	height	maximum diameter
UIMG 189	3.8	3.4
UIMG 190	3.8	3.5
UIMG 191	2.45	2.65
USNM 174741	—	3.85
USNM 174742	—	—
USNM 174743	3.70	3.25

Remarks. — This fine species may be readily distinguished from *Afrollonia togoensis* Adegoke, new species (= *Collonia* cf. *grandis* Oppenheim, 1915) by its more rounded whorls, the higher spire, and the presence of numerous spiral ribs and threads. The oblique plications which cover the latter are only weakly developed in the upper body whorl of the present species.

The new species is abundant at Ewekoro and was actively preyed upon by drilling gastropods (Pl. 11, figs. 12-15).

Afrollonia togoensis Adegoke, new species Pl. 11, figs. 16-20

Colonia cf. *grandis* Oppenheim, 1915, p. 36, pl. 2, figs. 14a-b (not Oppenheim, 1906); Furon, 1948, p. 102.

Description. — Shell small, spire low, consisting of about 3½ whorls, ornamented by two prominent spiral ribs. Body whorl large and moderately high, constituting more than ¾ of height, ornamented by three prominently carinated spirals and the oblique growth lines. Umbilicus narrow, deep and funnel-shaped, interior wall of outer chamber bears two noded spirals. An unnoded rib separates the latter from the inner chamber. Suture narrowly incised. Aperture subcircular.

Material. — Three, mostly incomplete specimens.

Types. — Holotype, the well-preserved specimen from Togo illustrated as *Collonia* cf. *grandis* by Oppenheim (1915, pl. 20, figs. 14a-b) is here designated as type specimen; paratypes, UIMG Nos. 192-193 and USNM 174744.

Dimensions (mm). —

	height	maximum diameter
UIMG 192	3.15	3.90
UIMG 193 (incomplete)	—	—
USNM 174744 (incomplete)	—	4.75

Remarks. — This species is sparsely represented at Ewekoro. Only three worn specimens were collected. They differ from *Afrollonia nigeriensis* Adegoke, new species by the greater prominence of the major spiral ribs, possession of two noded spirals on the inner wall of the outer umbilical chamber, the short spire and the well-developed oblique ridges produced by the growth lines.

The West African species differs from the probably closely related Egyptian species, *C. grandis* Oppenheim (1906, p. 218, pl. 20, figs. 12, 12a-c) by its shorter spire, fewer, unnoded spirals, and the more circular aperture.

Afrollonia angustiumbilicata Adegoke, new species Pl. 12, figs. 1-5

Description. — Shell small, moderately thick-walled and high-spired. Spire consists of four-five whorls which are rounded at the base and gently flattened in the apical half. Body whorl relatively large, faintly angulated in the upper and lower third. Shell ornamented by several subequal spirals, separated by narrow interspaces. First apical spiral and the two near the shoulder are more prominent than others. Eleven spirals occur between the suture and the lower angulation of the penultimate and body whorls, six below this point and the base. Aperture large and oval. Umbilicus narrow, with outer semilunar opening not bounded by a prominent spiral rim. A heavy spiral ridge, emanating from the columellar tip demarcates a small outer chamber from the inner chamber. A moderately thick callus covers the columella. Base ornamented by fine spirals.

Material. — Eighteen minute specimens.

Types. — Holotype, UIMG No. 194; paratypes, UIMG No. 195 and USNM No. 174745.

Dimensions (mm). —

	height	maximum diameter
UIMG 194	4.55	3.50
USNM 174745	5.20	3.95

Remarks. — This species resembles *Afrollonia nigeriensis* Adegoke, new species, but may be readily distinguished by its much higher spire, the rounded whorls, and the relatively coarser spiral sculpture. In addition, the umbilicus is narrower and lacks a prominent umbilical rim.

Subfamily **SOLARIELLINAE** Powell, 1951
Genus **SOLARIELLA** S. Wood, 1842

Solariella adedayoi Adegoke, new species Pl. 12, figs. 6-11, 14

Description. — Shell small, spire low, consists of about four broadly convex whorls, constituting less than 1/5 height of shell. Protoconch small, rounded, smooth like the other postembryonic whorls.

Body whorl large, with subrounded peripheral outline, gently rounded lower portion separated from flattened to gently concave apical portion by a weakly noded spiral band (Pl. 12, figs. 6, 8). The flattened apical portion is devoid of spiral sculpture but bears sinuous growth rugae (Pl. 12, fig. 8). Spire and body whorls ornamented by numerous fine spiral threads.

Umbilicus wide and deep with a funnel-shaped outer chamber along the walls of which the nodes of the umbilical rim are continued. Inner umbilical wall steep.

Aperture rounded to subrounded, snugly fitted by a spirally coiled operculum with a depressed central field and a broad, elevated outer rim.

Material. — Forty-one specimens.

Types.—Holotype, UIMG No. 195; paratypes, UIMG Nos. 196-197, USNM Nos. 174746-174748; PRI Nos. 29771, 29772.

Dimensions (mm).—

	height	maximum diameter
UIMG 195	1.05	2.90
UIMG 196	1.05	2.75
UIMG 197	1.35	3.10
USNM 174746	1.30	2.45
USNM 174747	1.65	2.95
USNM 174748	1.00	2.05

Remarks.—This species is represented by 41 specimens. Its major characteristics include the low spire, rounded body whorl which is flattened or gently concave apically and the wide umbilicus with its prominently nodulated rim.

The new species shows considerable variation in the degree of roundness of the body whorl, the flattening of the apical margin, and the nodulation of the umbilical rim.

The new species is named in honor of my son, Adedayo Adegoke.

Genus **NORRISIA** Bayle, 1880

Subgenus **NORRISELLA** Cossmann, 1888

Norrisia (Norrisella) sp. cf. **N. aurilitoralis** Cox Pl. 12, figs. 12, 13

Norrisia (Norrisella) aurilitoralis Cox, 1952, p. 46, pl. 5, figs. 4a, b.

Material.—One poorly preserved internal mold

Type.—Hypotype, UIMG No. 198.

Dimensions.—Height 3.35 mm; maximum diameter 4.00 mm.

Remarks.—A single internal mold of a *Norrisia* lacking much of the spire was collected at Ewekoro. The preserved apical whorl is rounded and there is a gradual increase in diameter as subsequent whorls are added. The suture is linear. The body whorl is robust and is uniformly rounded. Fragmentary shell remains show that the shell is probably smooth. The aperture is subcircular and the umbilicus is narrow.

The gross morphologic features of this specimen agree with those of *N. (N.) aurilitoralis,* a species described by Cox (1952) from the Apatuema Limestone in Ghana.

Genus **MIRACHELUS** Woodring, 1928

Mirachelus adeyemoi Adegoke, new species Pl. 12, figs. 15-18

Description. — Shell small, spire high, with gentle taper, apical angle about 45°. Protoconch and first two postembryonic chambers smooth and rounded. Adapical edges of spire whorls thickened slightly and noded, they overhang the suture. Body whorl high, more than one-third height of shell. Base imperforate.

Sculpture consists of coarse spiral threads, three on late spire whorls and 12 on the body whorl. They are beaded where traversed by the numerous, even-spaced axial ribs. Suture linear, deeply impressed. Columella short, thickened slightly and gently curved. Outer lip thin, labral denticles not observed.

Material. — Two microscopic specimens.

Types. — Holotype, UIMG No. 199; paratype, USNM No. 174749.

Dimensions (mm). —

	height	maximum diameter
UIMG 199	1.7	1.0
USNM 174749	1.9	1.1

Remarks. — This species is characterized by its minute size, the imperforate base, the slightly thickened columella, the reticulate sculpture and the depressed suture overhung by the abapical edge of the preceding whorl. These features closely resemble those of the type and other species of *Mirachelus* Woodring. The present species differs only in the absence of labral denticulations.

The present record from the Paleocene of Nigeria extends the stratigraphic range of the genus recorded to date only from Miocene to Recent. It also considerably extends the geographic range.

The new species is named in honor of Mr. D. A. Adeyemo, Production Manager of the West African Portland Cement Company, Ewekoro, Nigeria.

Superfamily **RISSOACEA** H. and A. Adams, 1854

Family **RISSOIDAE** H. and A. Adams, 1854

Genus **RISSOINA** d'Orbigny, 1840

Rissoina nigeriensis Adegoke, new species Pl. 12, figs. 19-20

Description. — Shell small, consisting of about seven gently convex whorls which are moderately inflated about the middle. Protoconch small, rounded; nuclear whorls consist of 2½ smooth whorls. Spire and body whorls wider than high, sculptured by several extremely fine and closely set axial threads separated by interspaces that are as wide as the axials. No spiral sculpture seen.

Aperture incomplete, probably hemispherical. Outer lip thick; thin callus deposit present on the inner edge of columella.

Material. — One well-preserved specimen.

Type. — Holotype, UIMG No. 200.

Dimensions (mm). — Height 3.45 mm; maximum diameter 1.60 mm.

Remarks. — This species is described on the basis of one specimen. It is characterized by the numerous, extremely fine axial sculpture. Its morphologic features are reminiscent of those of the subgenera *Zebinella* Mörch and *Mirarissoina* Woodring (Wenz, 1939, p. 626; Woodring, 1928). It differs from species of the former by its lack of spiral sculpture and the presence of parietal callus; and from the latter by the lack of the constricted adapical canal of the aperture.

Superfamily **SUBULITACEA** Lindstrom, 1884

Family **PSEUDOMELANIIDAE** Fischer, 1885

Genus **BAYANIA** Munier-Chalmas in P. Fischer, 1885

Bayania cheneyi Adegoke, new species Pl. 31, figs. 11-14

Description. — Shell small to minute, with high spire of about six-seven whorls which increase gradually in diameter as added. Apical whorls gently convex, devoid of ornamentation. Suture distinct, linear, impressed.

Body whorl high, constituting in adults about half the height of the shell, uniformly and gently rounded, also smooth. Aperture obliquely oval, inner lip margin sinuous. Anterior rim emarginate lacking siphonal canal and callus deposit.

Material. — Four nearly complete specimens.

Types. — Holotype, UIMG No. 201; paratypes, UIMG No. 202, USNM Nos. 174750, 174751; PRI Nos. 29773, 29774.

Dimensions (mm).—

	height	maximum diameter
UIMG 201	3.10	1.35
UIMG 202	4.45	2.00
USNM 174750	4.60	2.10
USNM 174751	2.75	1.10

Remarks. — This species is characterized by its minute size, the high spire which is only slightly higher than the body whorl, and the complete aperture.

The new species differs from ?*Bayania* sp. indet. (see below) by the absence of callosity on the columella.

The new species is named in honor of Mr. R. J. Cheney, Chairman and Managing Director of the West African Portland Cement Company, Lagos.

?Bayania sp. indet. Pl. 31, fig. 15

Material. — An incomplete body whorl.

Illustrated specimen. — UIMG No. 203.

Remarks. — An incomplete specimen consisting of body whorl and part of the penultimate whorl collected from the Ewekoro quarry is here referred doubtfully to *Bayania*. The whorl profile and the absence of sculpture suggests affinity with *Bayania cheneyi* Adegoke, new species. It differs in possessing a well-defined columella with a moderately thick callus deposit.

Order CAENOGASTROPODA Cox, 1959

Superfamily **CERITHIACEA** Fleming, 1822

Family **CERITHIIDAE** Fleming, 1822

Subfamily **CAMPANILINAE** Fleming, 1822

Genus **CAMPANILE** Bayle in Fischer, 1884

Campanile nigeriense Adegoke and Dessauvagie Pl. 12, figs. 21-23

Campanile nigeriense Adegoke and Dessauvagie, 1970, p. 329, pl. 1, figs. a-f.

Types. — Holotype, UIMG No. 19; paratypes, UIMG Nos. 20-23; hypotypes, PRI No. 29775.

Remarks. — *Campanile nigeriense* is characterized by its heavy, smooth adult shell, and the absence of axial sculpture. Juvenile whorls (Pl. 12, figs. 21, 22) bear four broad and smooth spiral ribs of which the adapical is the broadest. The spire is high, consisting in the adult of over 20 gently tapering low whorls (see reconstruction *in* Adegoke and Dessauvagie, 1970, fig. 2). The suture is deeply incised.

The aperture is quadrate, wide on young whorls but narrow on adults. The columella is straight and stout, bearing two strong plications (Pl. 12, fig. 23) of which the anterior is more prominent.

C. nigeriense probably attained an adult size of up to 200 mm (about 8 inches). They probably dragged their shells along the substrate when fully grown.

Subfamily **CERITHIINAE** Fleming, 1822

Wendella Adegoke, new genus

Diagnosis. — Medium-sized fusiform cerithiid with shell tapering uniformly at both ends. Spire high, consisting of about 9-10 straight-sided to gently convex whorls which increase progressively from the apex. Penultimate whorl wider than body whorl. Body whorl almost twice as wide as high, tapers gently to an abruptly truncated anterior end. Aperture small, subquadrate. Moderately thick parietal callus present. Columella slightly recurved.

Type species. — *Cerithium globoleve* Harris.

Remarks. — The distinguishing features of this new genus are its smooth, fusiform shell in which the penultimate whorl is widest, and the curved columellar tip. These features are strongly reminiscent of those of the problemmatic Gulf Coastal United States Midway specimen described as *Cerithium globoleve* by Harris (1896, p. 106, pl. 11, fig. 2). The generic position of the species has subsequently been uncertain. Cossmann (1906, p. 88) referred it to *Rhinoclavis,* while Palmer and Brann (1966, p. 588) assigned it to ?*Clavocerithium.* The problem of correct generic assignment was difficult to solve because closely comparable material had not been found since Harris' Midway study.

The new genus differs from cerithiids with identical adult body form such as *Cerithium* and *Bellatara* by the complete absence of sculpture and the relatively wide penultimate whorl.

The new genus is named in honor of Dr. Wendell P. Woodring, Smithsonian Institution, Washington, D.C.

Wendella nigeriensis Adegoke, new species Pl. 12, figs. 24-25; Pl. 13, figs. 1, 2

Description. — Shell fusiform, medium-sized, and smooth, tapering gently and uniformly at both ends. Spire high, consisting of about 9-10 straight-sided to gently convex, low whorls. Apical sculpture seemingly absent.

Base of penultimate whorl wider than that of body whorl. Body whorl is truncated abruptly near the anterior end. Aperture small, subquadrate, less than half the height of the body whorl. Anterior canal short and narrow, gently recurved. A moderately heavy callus is deposited on the parietal surface. Suture distinct, linear. Growth line consists of an oblique but straight apical portion (making an angle of about 30° with the shell axis) and a broadly recurved lower portion.

Material. — The new species is based on three well-preserved specimens.

Types. — Holotype, UIMG No. 204; paratypes, UIMG No. 205, USNM No. 174752.

Dimensions (mm). —

	height	maximum diameter
UIMG 204	39.65	18.15
UIMG 205	33.30	15.12
USNM 174752	42.20	17.42

Remarks. — This new genus and species is based on three well-preserved specimens, much of the apical whorls of which are lost. Details of the aperture and anterior canal are preserved on the holotype (Pl. 12, figs. 24, 25).

The new species differs from *Wendella globoleve* (Harris) by its less abrupt taper, the smoother whorls of which the penultimate is widest, the linear, non-channelled suture, and the more curved growth lines.

The occurrence of both the Nigerian and the American species in strata of Paleocene age indicates that *Wendella* may be an index to the Paleocene.

Genus **CERITHIUM** Bruguière, 1789

Subgenus **NIGERITHIUM** Adegoke, new subgenus

Diagnosis. — Medium-sized cerithiid, with high, gently tapering spire of several whorls. Spire whorls low, whorl width more than twice height, sides gently convex. Body whorl higher than wide.

Shell bears a series of prominent unevenly spaced axial ridges not continuous from whorl to whorl, 11 ridges present on body whorl, 10 on penultimate whorl. Spiral sculpture faint and supressed. Columella short, cylindrical and folded; labral edge sinuous. Growth line doubly flexed with broadly curved and shallow anterior and posterior sinuses.

Type species. — *Cerithium (Nigerithium) coorayi* Adegoke, new species.

Remarks. — This new subgenus is characterized by its well-developed axial sculpture, the supression of spiral ornamentation, the short, folded columella, and the shallow, broadly curved growth lines.

It superficially resembles *Texmelanatria* Palmer (1937, p. 181, as *Texania*) in the possession of prominent axial sculpture but differs in lacking spines. It similarly shows superficial resemblance to the Peruvian potamidid genus, *Lagunitus* Olsson (1929). The straighter axial ribs, the sinuous growth lines, the columella, and the outer lip features indicate a cerithiid rather than a potamidid affinity.

The new subgenus is named for its Nigerian occurrence.

Cerithium (Nigerithium) coorayi Adegoke, new species Pl. 13, figs. 3-6

Description. — Shell medium-sized, with high spire of several whorls which increases gradually in diameter as added. Spire whorls low, twice as wide as high, whorl profile gently convex. Body whorl high, slightly inflated and rounded. Whorls ornamented by moderately wide, straight axial ridges with rounded profile, separated by equally wide interspaces. Eleven axial ribs present on body whorl, 10 on penultimate whorl. Ribs often discontinuous from whorl to whorl.

Spiral sculpture faint or completely supressed, consists on the spire of two narrow and shallow grooves which intersect and subdivide the axial ridges into three subequal portions. Grooves more numerous but equally faint on the body whorl. Base more or less smooth, gently convex. Columella short, hollow and cylindrical. Aperture obliquely oval with a thin to moderately thick labral margin. Suture distinct, slightly wavy.

Material. — Three incomplete specimens.

Types. — Holotype, UIMG No. 206; paratypes UIMG No. 207, USNM No. 185035.

Dimensions (mm). —

	height	maximum diameter
UIMG 206	23.90	12.55
UIMG 207	36.54	17.15
USNM 185035	40.80	17.10

Remarks. — *Cerithium (Nigerithium) coorayi* Adegoke, new species, is characterized by its axial sculpture a few of which are discontinuous from whorl to whorl. It is the only species referred to the new subgenus.

The new species is named in honor of Professor P. G. Cooray, formerly of the Department of Geology, University of Ife.

Genus **DRUIDWILSONIA** Adegoke, new genus

Diagnosis. — Small to medium-sized, thick-walled, conical cerithiid. Spire short, consisting of about seven whorls which increase rapidly but uniformly in diameter as added. Apical angle varies between 32° and 36°. Spire and body whorls low, with straight to gently convex sides. Body whorl about twice as wide as high, sharply angulated at the base. Base plano-convex. Aperture small, compressed, lips thick-walled. Suture distinct, linear, narrowly incised. Growth line gently and uniformly curved, slightly inclined, growth line angle about 20°. The new genus is named in honor of Druid Wilson, U.S. Geological Survey, Washington, D.C.

Type species. — *Druidwilsonia nigeriana* Adegoke, new species.

Remarks. — This new genus is characterized by its short, conical, thick-walled shell, the rapid taper, the low whorls and the compressed aperture.

Its general shape is comparable to that of the turritellid genus described below as *Reymentella* Adegoke, new genus from which it may be readily distinguished by the thick shell, the rapid taper, and the nonturritelid growth line and lip features.

The conical shape is also reminiscent of that of *Thalotia* Gray, 1847, especially the subgenus *Odontotrochus* Fischer, *in* Kiener, 1879 (Wenz, 1938, p. 305). It differs from these by its smooth, thicker, non-umbilicate shell, the rounded aperture, and the growth line.

Druidwilsonia nigeriana Adegoke, new species Pl. 13, Figs. 7-14

Description. — Shell small to medium-sized, thick-walled, conical, with rapid taper. Spire consists of at least seven or more low whorls which increase rapidly in diameter as added. Apical angle 32° to 36°. Whorl width about three times the height. Protoconch small, smooth, inflated, leading into a nuclear chamber about one whorl long. Body whorl relatively high, angulated near the anterior border. Base plano-convex, bearing a few faint spiral threads.

Growth lines distinct, consisting of a shallow, broadly arched sinus, with point of maximum curvature anterior to the midpoint of the whorl. Growth line angle about 20°. Columella short and stout. Aperture small, compressed, with subovate outline. Suture distinct, linear and narrowly incised, overhung on adult whorls by the adapical edge of succeeding whorl (Pl. 13, figs. 9, 10), more or less parallel to the flattened base.

Material. — Over 20 nearly complete specimens representing almost all growth stages.

Types. — Holotype, UIMG No. 208; paratypes, UIMG No. 209, USNM No. 174753-174755, PRI No. 29776.

Dimensions (mm). —

	height	maximum diameter
UIMG 208	27.35	15.90
UIMG 209	12.95	8.90
USNM 174753	11.25	8.60
USNM 174754	13.00	7.75
USNM 174755	4.30	3.25

Remarks. — The diagnostic features of the new species are as described for the genus. *D. nigeriana* is the only species known.

Genus **BITTIUM** Leach in Gray, 1847

Bittium guineense Adegoke, new species Pl. 13, figs. 15-17

Description. — Shell small, turriconic, with high, uniformly tapering spire. Protoconch and earliest apical whorls unknown. Later whorls slightly angulated at base near the deeply channelled suture. Spire whorls ornamented by three spiral bands which increase in prominence from apex to the anterior. The two adapical bands are weakly noded.

Body whorl high, constituting about two-fifths height of shell, ornamented by three spirals of which the adapical two are heavier and noded while the third is narrow, elevated, and smooth. A weak fourth spiral band surrounds the basal angulation of the body whorl. Base flattened, sculptured by two broadly rounded spiral bands.

Columella narrow, short, and straight. Aperture subquadrate. Labrum thin, curved, bears on the interior surface five rows of short, pointed equidistant nodes (Pl. 13, figs. 16, 17). The rows correspond with the position of the exterior interspaces.

Material. — One well-preserved specimen.

Type. — Holotype, UIMG No. 210.

Dimensions. — Height 2.1 mm, maximum diameter 1.1 mm.

Remarks. — This elegant species is represented by one specimen. Its gross features resemble those of *Bittium (Bittium) reticulatum* (da Costa) the type species of the genus (Wenz, 1940, p. 756, fig. 2189; Nicklés, 1950, p. 63, fig. 74). This semblance is clearly brought out in the shapes of the columella and aperture, and the few spiral ribs. It differs from da Costa's species by its shorter, more symmetrical shell, the less convex whorls, the weakly noded spiral sculpture, the prominently channelled suture, and the presence of labral denticulations The same features also distinguish the new species from *B. transenna* (Bayan) figured from the Danian Calcaire de Faxe by Ravn (1933, pl. 3).

The presence of labral denticulations in this species is reminiscent of that of *Mirachelus* Woodring (1928). The anterior canal and outer lip features, as well as the absence of axial sculpture in the new species, distinguish it from species of *Mirachelus*.

Family **TURRITELLIDAE** Woodward, 1851

General statements. — As in other parts of the world, turritellids form an important component of the West African Tertiary fauna. Most known species were described as part of routine faunal (mostly molluscan) studies and have thus received little but casual attention. Besides, the published descriptions lack most of the data required for modern turritellid taxonomy, thus making revision difficult.

Though species of *Mesalia, Haustator,* and *Torquesia* have been recognized, a few workers have continued to apply indiscriminately the all-inclusive name, *Turritella* to these species (for example, Newton, 1922; Salvan, 1954). Close examination of the outer lip features, growth lines, and the ontogeny of the primary spirals does not seem to support the assignment of any of the West African Tertiary species of the genus *Turritella sensu stricto.*

Much interest has centered around the detailed classification of turritellids especially since the publication of Guillaume's (1924) essay. The advances to date were reviewed by Merriam (1941), Kotaka (1959), Allison (1965), Adegoke (1967), Allison and Adegoke (1969). Though Guillaume (*op. cit.*) advocated a classificatory system based solely on the sinuosity of the outer lip and its reflection on the growth line sinuses, most modern workers consider as important the following additional characteristics:

(a) shape of the protoconch
(b) apical angle
(c) growth line trace
(d) growth line angle
(e) details of aperture
(f) the ontogeny of the primary spiral ribs (= apical development).

An elaborate letter and numerical notational system has subsequently developed (Allison, 1965; Adegoke, 1967; Allison and Adegoke, 1969) to facilitate the description and comparison of species.

In this scheme, the first adapical primary spiral is designated A; B is the medial primary spiral; D is the peribasal spiral involved with the adapical suture, and C is the major primary spiral adapical to B. The secondary spirals are designated r, s, t, u in the following order: r is adapical to A; s is between primaries A and B; t is between B and C, and u is adapical to D. Marwick's (1957) and Kotaka's (1959) notations for designating tertiary spirals have not been frequently used because of the difficulty of determining accurately the point of insertion of these fine threads.

Capital letters (A, B, C, R, etc.) are used for primary and secondary spirals which are prominently elevated. The same spirals are denoted by lower case letters (a, b, c, r, etc.) if they are only weakly developed.

Arabic numerals (1, 2, 3, etc.) are used to denote the ontogenetic order of appearance of ribs.

In the present study, the Ewekoro turritellids are referred to the genera *Mesalia, Torquesia, Haustator,* and a new genus, *Reymentella.* Species designation was based in most cases on a study of nearly complete ontogenetic stages.

Subfamily **PAREORINAE** Finlay and Marwick, 1937

Genus **MESALIA** Gray, 1847

Mesalia fallockensis Tessier **ewekoroensis** Adegoke, new subspecies
Pl. 13, figs. 18-22

Mesalia koerti Oppenheim, Adegoke, 1972a, pl. 2, figs. 8, 9 (not Oppenheim, 1915).

Description. — Shell large, moderately thick-walled, with high, stubby spine consisting of about 9-10 whorls which increase in diameter abruptly as added. Apical angle about 35°; pleural angle about 40°. Protoconch and nuclear whorls not preserved. Earliest spire whorls low, slightly angulated at base, ornamented by four spiral bands between which are finer threads. Later spire whorls broader and more uniformly rounded. Body whorl high, slightly higher than wide, ornamented by about five broad, diffuse spiral bands between whic hare several finer threads. Gerontic body whorl not much wider than penultimate whorl (Pl. 13, figs. 19, 20), with obscure sculpture.

Suture linear, slightly impressed. Columella short, flattened, with thin callus deposit (Pl. 13, fig. 19) and two narrow columellar plications (Pl. 13, fig. 18). Growth line doubly flexed, with shallow and broadly curved antispiral sinus; maximum flexure coincides roughly with middle of the whorl. Base weakly sculptured by growth lines.

Material. — Over 30 well-preserved specimens without apex.

Types. — Holotype, UIMG No. 136; paratypes, UIMG No. 137, USNM Nos. 174756, 174757; PRI No. 29777.

Dimensions (mm). —

	height	maximum diameter
UIMG 136	48.00	24.05
UIMG 137	24.55	13.08
USNM 174756	39.75	20.85
USNM 174757	48.00	19.92

Remarks. — The diagnostic features of this new subspecies include its short stubby form, the irregular taper, the high pleural angle and the unevenly developed and faint spiral sculpture. It most closely resembles in size and whorl profile the species *Mesalia fallockensis* Tessier (1952, p. 362, pl. 29, fig. 28) described from the Paleocene of Senegal. It differs only in its fewer spiral ribs (seven per whorl in the Senegal species) and the irregular taper. The young forms of the new subspecies (Pl. 13, figs. 21, 22) superficially resembles the indeterminate species described as *Turritella (Archimediella)* by Tessier (*op. cit.*, p. 363, pl. 29, fig. 25) but differs by its shorter spire and the more rapid taper. These immature forms also resemble young forms of *M. fallockensis* illustrated by Chabaglian (1959, pl. 3, figs. 1, 3). Because of this close similarity in adult and immature forms, the Nigerian specimens are regarded as a geographical subspecies of the Senegal species.

Mesalia fallockensis ewekoroensis is one of the dominant elements of the Ewekoro malacofauna. It is represented by over 30 specimens including different growth stages.

Mesalia passi Adegoke, new species Pl. 14, figs. 1-5

Description. — Shell small, spire high, consisting of about 10-11 whorls of which the first seven increase uniformly in diameter while later ones show a less marked increase in diameter. Spiral angle 25-28°. Whorls ornamented by three heavy spirals which develop in the order C_1 B_2 A_3. B_2 is inserted soon after C_1 and rivals it in prominence throughout ontogeny. A_3 though inserted much later (about 5-6 whorls after B_2) also rivals B and C in prominence within its first two volutions. All three spirals are moderately noded, A_3 more so than B and C.

Suture distinct, impressed. Inner lip and posterior rim of aperture bears a flattened callus. Outer lip with broad, shallow antispiral sinus and a smaller anterior sinus. Aperture small, hemispherical, with faint median columellar fold (Pl. 14, fig. 2).

Material. — Three specimens.

Types. — Holotype, UIMG No. 212; paratype USNM No. 174758, UIMG No. 213.

Dimensions (mm). —

	height	maximum diameter
UIMG 212	23.50	8.92
UIMG 213	15.70	7.00
USNM 174758	15.85	7.80

Remarks. — This new species is characterized by the gentle taper, the high spire, and the three prominent spiral ribs. It superficially resembles *Mesalia rogersi,* new species, especially in its apertural features (Pl. 14, compare figs. 2 and 6). It may be readily distinguished by the three prominent, noded spirals, the gentle taper, the relatively narrower body whorl, and the shallower antispiral sinus of the growth line.

The new species is named in honor of Dr. Barry Pass, formerly of the Physics Department, University of Ife, who collected the holotype.

Mesalia rogersi Adegoke, new species Pl. 14, figs. 6-9

?*Mesalia (Sigmesalia) koerti* Oppenheim, Furon, 1948, p. 105, pl. 9, fig. 2 (not Oppenheim, 1915).

Description. — Shell small to medium-sized, maximum observed adult height (incomplete) 21.1 mm, maximum observed diameter of body whorl 10.3 mm. Spire moderately high, consisting of about seven-eight whorls which increase in diameter rapidly as added; apical angle about 30°. Spire whorls convex with no visible angulation, much shorter than broad.

Body whorl convex, slightly higher than broad. Whorls ornamented by five or six unequal, faint spirals of which the subequal adapical two are most prominent. Aperture moderately large, with subquadrate outline. Base smooth. Inner lip margin flattened, with thin parietal callus. Suture distinct, slightly impressed. Growth line is faint, consists of a broadly curved antispiral sinus with maximum depth about ⅓ height of whorl and a gently flexed basal sinus.

The ontogeny of the spiral ribs is difficult to trace. Three equally developed spirals are present on the youngest preserved apical whorls (with diameter about 2 mm). They are evenly spaced and are presumed to represent the primary spirals A, B, C. The whorl at this stage is covered by several fine threads. A fourth spiral (?D) is soon inserted between C and the suture. It rivals A, B, C in prominence within two volutions and its position migrates adapicalward during ontogeny. Lastly a fine thread (t?) is inserted between B and C.

Material. — The new species is based on three specimens.

Types. — Holotype, UIMG No. 214; paratypes, USNM Nos. 174759, 174760.

Dimensions (mm). —

	height	maximum diameter
UIMG 214	21.1	10.3
USNM 174759	19.2	7.7
USNM 174760	14.3	7.9

Remarks. — The diagnostic features of this new species includes the convex and uniformly rounded whorls, the wide, subquadrate aperture, and the spiral sculpture of five or six spirals.

The new species superficially resembles immature specimens of *M. fallockensis ewekoroensis* Adegoke, new subspecies, from which it may be readily distinguished from the species by its gentler, more uniform taper, the relatively higher spire, the more convex whorls, the more prominent spiral sculpture and in the disposition of the growth line sinuses. In the new species, the point of maximum inflexion of the antispiral sinus is located in the upper third of each whorl whereas it is between the lower half and third of the whorl of *Mesalia fallockensis ewekoroensis* Adegoke, new subspecies.

The new species also resembles the Senegalese Paleocene species, *Mesalia falloti* (Tessier) but may be distinguished by the more inflated whorls, the less deeply channelled suture, and the more numerous spiral ribs.

Mesalia salvani Adegoke, new species Pl. 14, figs. 10-16

?*Mesalia fasciata* Lamarck, Salvan, 1954, p. 111, pl. 8, figs. 9, 10 (not Lamarck, 1804; not Douvillé, 1928).

Description. — Small-sized turritellids, maximum observed size (incomplete) 8 mm, maximum observed adult diameter 3.4 mm. Spire relatively high, acutely pointed, consisting of about 10-12 whorls which increase uniformly in diameter as added; apical angle about 22°.

Early whorls smooth and rounded; later whorls strongly bicarinate, bearing two well-developed primary spirals representing B and C. Both spirals appear early and almost simultaneously in ontogeny on the 4th to 5th whorls and are subequal throughout. The peribasal, d is weakly elevated and bounds the suture. No trace of primary spiral A or of any secondary spiral was noted. Aperture is small, subrounded. Growth line trace faint, consists of a shallow uniformly curved posterior sinus whose point of maximum curvature occurs adapical to B. The anterior sinus is also weakly flexed.

Material. — More than 40 well-preserved specimens.

Types. — Holotype, UIMG No. 215; Paratypes, UIMG Nos. 216-218, USNM 174761-174763, PRI Nos. 29778, 29779.

Dimensions (mm). —

	height	maximum diameter
UIMG 215	7.55	2.60
UIMG 216	5.00	1.75
UIMG 217	3.65	1.65
UIMG 218	3.40	1.15
USNM 174761	2.75	1.05
USNM 174762 (incomplete)	3.05	1.65
USNM 174763	2.40	0.80

Remarks. — The diagnostic features of this species are the minute size and the presence of only two primary spirals, B and C. In these features, it closely resembles specimens described and figured as *Mesalia fasciata* Lamarck by Salvan (1954) from the Montian strata at Imi N'Tanout and Meskala, Maroc. Hence both are considered conspecific here.

Mesalia fasciata (Lamarck) is a controversial taxon first described from the Eocene of Paris Basin. The hototype has the three primary spirals, A, B, and C, and a subquadrate aperture. Several authors including Salvan (*op. cit.*) subsequently assigned specimens from a wide geographical area and straddling a considerable stratigraphic interval to the species. This material varies widely morphologically, including both tricarinate and bicarinate forms. The species has, accordingly, been labelled as *highly plastic.* For example, Douvillé's (1920, 1929) Soudanese and Sind material have three major spirals whereas the Egyptian material described as *M.* aff. *fasciata* Lamarck by Oppenheim (1906, p. 252, pl. 23, fig. 23) is bicarinate. The latter differs from the present (West African) species in having closely spaced spirals and more angulated whorls. It is, probably referrable to *Mesalia bilirata* Mayer-Eymar, 1902.

The new species is named in honor of Dr. H. Salvan.

Mesalia reymenti Adegoke, new species Pl. 14, figs. 17, 19, 20, 22

Description. — Shell small; spire high, consisting of about seven-eight rounded whorls which increase progressively in diameter as added. Apical angle varies between 30° and 32°. Suture distinct, deeply impressed. Protoconch missing. Earliest post-nuclear whorls smooth, later whorls ornamented by several subequally prominent spiral ribs separated by narrower interspaces. About eight spirals present on each spire whorl and about 10 on the body whorl. Aperture moderately wide, subrounded.

Growth lines distinct on some specimens, with a shallow broadly curved antispiral sinus whose maximum curvature coincides with the middle of the whorl and a similarly shallow spiral sinus. Both subtend a slightly negative growth line angle.

Material. — Forty specimens.

Types. — Holotype, UIMG No. 219; paratypes, UIMG No. 220, USNM Nos. 174764-174765, PRI Nos. 29780, 29781.

Dimensions (mm). —

	height	maximum diameter
UIMG 219	3.50	1.80
UIMG 220	1.60	1.05
USNM 174764	2.00	1.30
USNM 174765	7.50	3.65

Remarks. — This new species is characterized by its small size, the rounded whorls, and the numerous, subequal spiral threads. It differs from the two new species of *Mesalia* described below by its non-elongate, rounded whorls, the sub-rounded aperture and the absence of a prolonged anterior region of the aperture. Besides, none of its spiral ribs is more prominently developed than the others.

The new species is named in honor of Professor R. A. Reyment of the Paleontological Institute, Uppsala.

Mesalia akinolae Adegoke, new species Pl. 14, figs. 23-25

Description. — Shell minute with a short spire of about six-seven whorls which taper rapidly. Spire whorls rounded, slightly angulated in the abapical third.

Body whorl elongate, with maximum diameter near the abapical end. Whorls smooth or faintly sculptured in the adapical third, bearing in the lower portion several broad spiral ribs separated by narrow interspaces.

Aperture subrounded, with a short, emarginate anterior canal.

Material. — The new species is based on three specimens.

Types. — Holotype, UIMG No. 412; paratypes, UIMG No. 413, USNM No. 174894.

Dimensions (mm). —

	height	maximum diameter
UIMG 412	4.65	2.15
UIMG 413	2.90	1.60
USNM 174894	3.85	1.85

Remarks. — Among the species of *Mesalia* described from Ewekoro, only *Mesalia passi* and *M. rogersi* have a fairly rapid taper. Both differ from the present species in having only a few, heavy spiral ribs.

The new species has more elongate whorls and coarser sculpture than *M. reymenti* Adegoke, new species. It is named in honor of Mr. R. Akinola, Public Relations Manager, West African Portland Cement Company, Lagos.

Mesalia akinkugbei Adegoke, new species Pl. 14, figs. 26, 29, 30

Description. — Shell small, with high gently tapered spire. Spire whorls relatively large, consisting of about six-seven convex whorls. Body whorl only slightly larger than penultimate whorl.

Whorls beautifully sculptured by several fine spiral threads among which two spirals, one located medianly and the other in the abapical third, are heavier and more prominently elevated than the others. A few spirals on the abapical slope of the whorls are also prominent. Aperture oval.

Material. — The new species is based on three specimens.

Types. — Holotype, UIMG No. 410; paratypes, UIMG No. 411, USNM No. 174893.

Dimensions (mm). —

	height	maximum diameter
UIMG 410	9.25	3.20
UIMG 411	10.65	4.35
USNM 174893	8.75	2.95

Remarks. — This species differs from *Mesalia reymenti* Adegoke, new species, by the finer spiral sculpture, the less spherical whorls, and that two spirals are more prominent than the others.

This species is named in honour of Mr. Olu Akinkugbe.

Mesalia sp. A Pl. 14, figs. 27, 28

Mesalia sp. Furon, 1948, p. 105, pl. 9, fig. 4.

Remarks. — A few specimens of poorly preserved turritellids were collected. They are comparable with the indeterminate species figured by Furon (1948, *loc. cit.*). The shells are small (heights 7.05 and 3.95 mm; maximum diameters 3.55 and 2.2 mm respectively), with worn but rounded, short whorls. The shell is moderately thick and the aperture small and rounded. Their worn nature suggests that they may have been deeper water species washed into the shallower sublittoral environment.

Illustrated specimens. — UIMG No. 221, USNM No. 174766.

Mesalia sp. B Pl. 14, figs. 31-33

Remarks. — These are worn, thin-walled, high-spired turritellids. The whorls are elongated, attaining maximum diameter near the abapical end. The aperture is small and subrounded.

This species differs from *Mesalia* sp. A by its narrower, more elongate, thinner shell, and the less rapid taper. Like the latter, it probably represents a deeper water species washed into the shallower Ewekoro environment.

Dimensions (mm). —

	height	maximum diameter
UIMG 222	8.45	2.80
UIMG 223	6.25	1.75
USNM 174767	6.50	1.75

Illustrated specimens. — UIMG Nos. 222, 223, USNM No. 174767.

Subfamily **TURRITELLINAE** Woodward, 1851

Genus **TORQUESIA** Douvillé, 1929

Torquesia adabionensis (Oppenheim) Pl. 15, figs. 1-4

Turritella adabionensis Oppenheim, 1915, p. 41, pl. 3, figs. 7a, b; Furon, 1948, p. 104.
Torquesia adabionensis (Oppenheim), Adegoke, 1972a, pl. 2, fig. 6.

Description. — Shell medium to large-sized, thick-walled. Maximum height of incomplete specimen 53.8 mm, maximum diameter of largest collected fragment 16.7 mm. Spire high, tapering gently, apical angle about 20°. Spire whorls straight-sided, ornamented on young whorls by a heavy spiral band which forms a more or less distinct shoulder below which are five weaker spirals. On adult whorls, spiral sculpture is subdued and few (Pl. 15, figs. 1, 2).

Growth lines prominently developed, with gently slanting adapical portion followed by a narrow, deeply folded antispiral sinus whose maximum curvature is slightly adapical to the middle of the whorl. Spiral sinus is broad and shallow; growth line angle about 13°. The aperture is small and rounded.

Material. — Sixteen fragmentary specimens.

Types. — Hypotypes, UIMG Nos. 134, 225, USNM No. 174768, PRI No. 29782.

Dimensions (mm). —

	height	maximum diameter
UIMG 134	53.8	16.0
UIMG 225	32.5	14.2
USNM 174768	41.95	13.7

Remarks. — The general shape and the growth line of this species is reminiscent of *Torquesia nuttalli* Douvillé, 1929 from the *Cardita beaumonti* beds at Sind. It differs by its more prominent spiral ornamentation, less prominent adapical shoulder, and the deeper antispiral sinus.

T. adabionensis differs from *T. elicitatoides* Maury *senegalensis* Tessier by the more prominent shoulder on each whorl and the presence of more prominent spiral ribs.

Torquesia oppenheimi Adegoke, new species Pl. 15, figs. 5-12

Turritella cf. *Hollandei* [*sic*] Cossmann and Pissarro, Oppenheim, 1915, p. 38, pl. 3, figs. 2-6 (not *T. hollandi* Cossmann and Pissarro, 1909, p. 60, pl. 5, figs. 17-19).

Turritella cf. *Hollandi* Cossmann and Pissarro, Furon, 1948, p. 104.

Description. — Small to medium-sized turritellids; maximum observed height (incomplete) 31.7 mm, maximum observed diameter 10.5 mm. Spire high, tapers gently and uniformly, apical angle about 15°. Protoconch and earliest whorls not preserved. The three primary spirals, A, B, C present and prominently developed on all adult whorls. On the youngest available specimen, C is slightly more prominent than B which is also more prominent than A, suggesting a C_1 B_2 A_3 apical ontogeny. The spirals are smooth and sharply elevated on immature specimens (Pl. 15, figs. 8-12). Later in development, A becomes subequal to B and C, and all become prominently noded (Pl. 15, figs. 5-7).

On intermediate whorls, S appears as a thin spiral band which becomes prominent after about four volutions. In some specimens, two fine threads appear in the t position about two volutions after the appearance of s. The spiral, u appears subsequently, but remains very fine.

Suture is conspicuous, occasionally slightly appressed. Aperture low, subquadrate. Growth line conspicuous, begins with an oblique slant over the position of A, swinging thereafter into a deep, broadly curved antispiral sinus whose maximum curvature coincides with the position of B. The spiral sinus is shallow and broadly curved; growth line angle about 15°. Aperture high, subquadrate.

Material. — Twelve specimens lacking the earliest apical whorls.

Types. — Holotype, UIMG No. 226; paratypes, UIMG Nos. 227-229, USNM Nos. 174769-174772. PRI Nos. 29784, 29785.

Dimensions (mm). —

	height	maximum diameter
UIMG 226	32.10	10.35
UIMG 227	24.20	5.75
UIMG 228	2.7	0.85
UIMG 229	23.30	9.55
USNM 174769	25.50	7.25
USNM 174770	21.0	7.0
USNM 174771	22.00	7.65
USNM 174772	25.52	6.00

Remarks. — This is a variable species. The young whorls differ markedly from the adult whorls by their non-noded spirals (Pl. 15, figs. 8-12). In later whorls, noding becomes dominant.

The new species bears superficial resemblance to *Turritella hollandi* Cossmann and Pissarro (1909) especially in possessing three prominent spirals. It differs in its apical ontogeny (A_3 B_2 C_1). In the Ranikot species, the probable order of appearance, judging from prominence of earliest ribs is A_3 B_1 C_2. The Indian taxon is a true *Turritella.* The new species differs further by its more conspicuous taper, the strongly noded spirals, the pronounced development of S, the growth line, and the apertural features.

The sculpture of this species is grossly reminiscent of that of *Turritella marocana* Moret (1938, p. 15, pl. 4, figs. 1-4; Salvan, 1954, p. 118) especially in the change from a finely sculptured tricostate early whorls to the more coarsely sculptured adult whorls. The median primary, B is, however, less prominent in the new species and the adult sculpture is less prominent than in Moret's species.

Adult specimens of *H. oppenheimi* Adegoke, new species, develop sculpture that is superficially like those of *Torquesia adabion-*

ensis (Oppenheim). Their growth line traces are also comparable (compare Pl. 15, figs. 1, 2, 5). They differ in that *T. adabionensis* is larger, with straighter-sided whorls, lacking in prominent spiral ribs.

The Nigerian specimens illustrated here are identical with the Togolese material referred to *T. hollandi* Cossmann and Pissarro by Oppenheim (1915) and Furon (1948). Both are here considered conspecific.

The new species is named in honor of P. Oppenheim.

Haustator furoni Adegoke, new species Pl. 15, figs. 22-24

Description. — Small-sized turritellids; spire high, consisting of about eight or nine whorls which increase gently in diameter as added. Apical angle about 20°. Spire and body whorl smooth but for extremely fine primary and secondary threads. Primary spirals arise in the ontogenetic order $a_3b_2c_1$. The spiral c appears about the 4th or 5th whorl, closely followed by b; a_3 is inserted about 2½ whorls later. The primary spirals, as well as secondary spirals, remain faint and inconspicuous throughout development.

Body whorl elongate, about twice as high as wide. Suture distinct, deeply furrowed. Growth line conspicuous, antispiral and spiral sinuses shallow and broadly curved, maximum depth of antispiral sinus occurs in the adapical third of the whorl and that of the spiral sinus in the abapical third of the whorl. Growth line angle about 18°. Aperture small, elongate-oval.

Material. — Two well-preserved specimens.

Types. — Holotype, UIMG No. 230; paratype, USNM No. 174773.

Dimensions (mm). —

	height	maximum diameter
UIMG 230	18.60	5.45
USNM 174773	17.42	6.62

Remarks. — The diagnostic features of this species are the doubly sinused growth lines, the gently rounded whorls, the furrowed suture, the elongate aperture, and the subdued spiral sculpture.

It may be readily distinguished from *Turritella vredenburgi* Douvillé, 1929, from Sind, India, by its wider suture, the more rounded whorls, and the shallower growth line sinuses.

The Togolese specimens described and figured as *Turritella (Torquesia)* cf. *vredenburgi* Douvillé by Furon (1948) tapers more rapidly than *H. furoni* and lacks the channelled suture of the new species. Its general appearance suggests that it is not a turritellid.

The present species is named in honor of Professor Raymond Furon.

Haustator nigeriensis Adegoke, new species Pl. 16, figs. 1-7

Haustator, n. sp. Adegoke, 1972a, pl. 2, fig. 7.

Description. — Small to medium-sized turritellids, maximum observed adult height (incomplete) 28.1 mm, maximum observed diameter 11.3 mm. Spire high, increasing gently in diameter as whorls are added; apical angle between 18° and 22°. Spire whorls wider than high. All three primary spirals develop in close succession on the 4th to 5th whorls and remain subequal throughout ontogeny; order of appearance of spirals not determined. Secondary spiral s develops early (about 6th - 7th whorl), soon rivals the primary spirals in prominence, intermediate whorls thus have four subequal ribs. Conspicuous secondary and tertiary threads occur between these four ribs.

On adult whorls, t appears and soon gains prominence, leaving five ribs on most adult whorls. Base ornamented by about 12-20 fine threads.

Growth line doubly sinused with a moderately deep and broad antispiral sinus with maximum depth occurring between A and S, but closer to S. Spiral sinus shallow, sharply flexed on C.

Suture deeply channelled with d forming a subprominent angulation on the adapical wall. Aperture oval in young, subquadrately rounded in adults.

Material. — About 124 mostly immature specimens.

Types. — Holotype, UIMG No. 135; paratypes, UIMG Nos. 232-233, USNM Nos. 174774-174776, PRI Nos. 29786, 29787.

Dimensions (mm). —

	height	maximum diameter
UIMG 135 (incomplete)	26.10	9.15
UIMG 232	18.15	4.35
UIMG 233	18.85	4.75
USNM 174774 (incomplete)	21.45	10.25
USNM 174775 (incomplete)	22.30	10.05
USNM 174776 (incomplete)	17.45	11.90

Remarks. — The diagnostic features of the new species are its deeply grooved sutures, the narrow, prominently raised spirals, and the early development of two secondary spirals giving the adult whorls five subequal ribs.

The new species may be readily distinguished from *Turritella crocodili* Oppenheim, 1906 by its lighter more uniformly tapered shell and the unnoded spirals. The sculpture of the new species is similar to that of the Mokattam species referred to *Mesalia hofana* Mayer-Eymar by Oppenheim (1906, Pl. 22, figs. 20, 21), it differs, by its slender shell, the less rounded whorls, the deeper suture as well as by the growth line and apertural features.

The new species is the most abundant turritellid at Ewekoro. It is represented in my collection by about 124 specimens, most of which are immature shells less than 10 mm high.

Haustator oyawoyei Adegoke, new species Pl. 16, figs. 8-14

Description. — Small to medium-sized turritellids, maximum observed adult height about 35.7 mm, maximum observed diameter about 7.9 mm. Shell slender with high, gently tapering spire of probably over 15 whorls; apical angle about 12°. Whorls more or less straight-sided, gently angulated at the positions of the three primary spirals. Protoconch and earliest post-nuclear whorls not preserved. The three primary spirals already present on youngest available whorl (diameter 0.4 mm). C is more prominent that B which is, in turn, more prominent than A, suggesting a A_3 B_2 C_1 apical development — and the genus *Haustator*. B_2 becomes abruptly suppressed about two volutions later (A_3 b_2 C_1). All three primary spirals are strongly noded.

Secondary spiral threads appear early in ontogeny, order of insertion not determinable, a few were visible on whorls with diameter of 0.9 mm on the smallest specimen studied. On youthful whorls with diameter about 4.6 mm, s, t and u as well as a number of tertiary threads all weakly noded, are present (Pl. 16, fig. 10).

On the penultimate and last whorls of the holotype (diameter 7.3 mm), the following were observed: a faint thread between A and S, two threads between b and t, and also between t and C, five unequal spirals between C and d.

Suture is distinct, narrow, incised, located at the base of a wide channel between the elevated spirals A and d. Aperture oval. Base ornamented by several spirals with finer threads in the interspaces.

Growth line distinct (Pl. 16, figs. 8, 9) with moderately deep and broadly curved antispiral sinus with maximum depth occurring between s and b; spiral sinus sharply flexed on C, with a less pronounced flexure on d.

Material. — Six well-preserved specimens.

Types. — Holotype, UIMG No. 234; paratypes, UIMG Nos. 235-236, USNM Nos. 174777-174779.

Dimensions (mm). —

	height	maximum diameter
UIMG 234	29.90	7.95
UIMG 235	5.70	1.35
UIMG 236	15.60	3.55
USNM 174777	18.40	7.65
USNM 174778	23.85	6.45
USNM 174779	35.85	8.45

Remarks. — The diagnostic features of this species are the gently tapering shell, the suppression of b throughout ontogeny, the strongly noded primary spirals, and the well-developed secondary and tertiary threads.

The deeply channelled suture is reminiscent of that of *Haustator nigeriensis* Adegoke, new species. They differ in the details of their spiral sculpture.

The new species is named in honor of Professor M. O. Oyawoye, Department of Geology, University of Ibadan, Ibadan.

Haustator? new species Pl. 16, fig. 15

Remarks. — A fragmentary specimen about four whorls long was collected at Ewekoro. The whorls are straight to gently convex, tapering only slightly and the suture is channelled. Each whorl bears four subequal, uniformly spaced spirals. A fifth but much finer spiral occurs abapical to the suture.

The whorl shape and suture is suggestive of *Haustator,* but the sculpture precludes assignment to any of the species described above.

Illustrated specimen. — UIMG No. 237.

Genus **REYMENTELLA** Adegoke, new genus

Diagnosis. — Small-sized, conical, thin-walled turritellid, apical angle about 25°. Protoconch small, bulbous and smooth; first two post-nuclear whorls gently convex, later whorl sides straighter. Five spirals appear almost simultaneously on the third spire whorl, they represent r, a, b, c, and d(?). All five spirals subequal at first appearance with a, b and c later becoming more prominent than others; position of a migrates abapically during ontogency. Other spirals to a total of 11 develop on adult whorls; of these, two are adapical to a, three lie between a and b, and two fine threads occur in the excavated interspace between b and c, and one between c and the peribasal d.

Growth line inconspicuous, with a deep and broadly curved antispiral sinus with the deepest part on b, and a narrower sharply flexed spiral sinus with the major flexure on d. Suture well defined, impressed. Base plano-convex, ornamented by several fine spirals with finer threads in the interspaces. Aperture small, low, with an oval-trigonal outline.

Type species. — *Reymentella olaniyani* Adegoke, new species.

Remarks. — The diagnostic characters of *Reymentella* are its small, conoidal shell, the apical development in which five primary and secondary spirals develop almost simultaneously, the plano-convex base, the low trigonal aperture, and the growth line trace.

The shape of the shell is reminiscent of those of some Tertiary species referred to *Elenchus (Thalotia),* but its turritellid features and the absence of an umbilicus prevent its inclusion in that genus.

The conical shape similarly resembles that of *Druidwilsonia* Adegoke, new genus. They differ because *Reymentella* is thinner shelled, with spiral sculpture, linear suture, a flattened base, and trigonal aperture. Additionally, the turritellid growth line of *Reymentella* is unlike the single-sinused growth line of *Druidwilsonia.*

The growth line trace, especially the lateral sinus resembles that of *Haustator.* The less sinuous spiral sinus, the flattened base, the apertural characters, and more important, the apical development prevent its inclusion within *Haustator.* They may be closely related.

The double-sinused growth line, slightly curved columella and the absence of a spiral ridge on the adapical columellar lip, show that *Reymentella* is a member of the subfamily Turritellinae (Marwick, 1957, p. 149).

The new genus is named in honor of Professor R. A. Reyment of the Paleontological Institute, Upssala.

Reymentella olaniyani Adegoke, new species Pl. 15, figs. 13-21

Description. — Small-sized, thin-walled turritellids; maximum observed adult height 14.4 mm, maximum observed adult diameter 4.9 mm. Spire moderately high, consisting of about 11-12 whorls which increase in diameter gradually as added; apical angle 25°. Protoconch moderately small, bulbous and smooth. First two postnuclear whorls also smooth. Five spiral ribs representing r, a, b, c and d develop almost simultaneously on the 3rd spire whorl. Spirals are subequal at the point of insertion, a, b and c become more prominent than others about 1½ whorls later. Spiral a migrates abapically during ontogeny, finally occupying a position about one-third of the way down the height of the whorl, with the distance between it and adapical suture greater than the interspace between it and b. Spiral c is also slightly closer to b than the latter is to a.

About 11 or 12 spiral ribs present on adult whorls, of these, two fine threads are adapical to a, three equidistant threads occur between a and b, two in the concave interspace between b and c, and one fine thread between c and d. On some more adult whorls, a few more threads may be inserted in the interspaces and d forms a broad band adapical to and partially obliterating the suture.

Suture distinct, impressed. Base flat to gently convex. Aperture small, oval-trigonal in outline, with thin walls. Growth line sinus as described for genus.

Material. — The new species is abundantly represented by about 60 specimens.

Types. — Holotype, UIMG No. 238; paratypes UIMG Nos. 239-241, USNM Nos. 174780-174783, PRI 29818, 29819.

Dimensions (mm). —

	height	maximum diameter
UIMG 238	3.90	1.80
UIMG 239	4.05	1.85
UIMG 240	3.85	1.75
UIMG 241	3.00	1.40
USNM 174780	7.60	3.55
USNM 174781	4.80	2.10
USNM 173782	10.30	4.20
USNM 174783	2.75	1.15

Remarks. — This new species is presently the only known representative of the new genus *Reymentella.* It is based on over 60 specimens collected from the Ewekoro quarry. About half of these are immature specimens, less than 3 mm high. Predation by carnivorous gastropods is common and some specimens were attacked more than once (Pl. 5, figs. 14-17).

The new species is named in honor of Professor C. I. O. Olaniyan, School of Biological Sciences, University of Lagos, Lagos, Nigeria.

Family **EWEKOROIDAE,** new family

Diagnosis. — Small to medium-sized, cyrtoconoid shells, with high spire of over ten whorls and apical angle ranging between 22° and 27°. Body whorl elongate and gently convex. Whorls smooth to ornamented. Suture distinct, linear. Columella flattened and spirally twisted, bounded adapically by a variably developed plication. Growth line sigmoid, opisthocline, often partially to completely elevated to form growth rugae.

Genus **EWEKOROIA** Adegoke, new genus

Diagnosis. — Small to medium-sized cerithiid, terebriform. Spire high consisting of a large number (9-11) of flat-sided to gently convex whorls. Apical angle variable, ranges between 22° and 27°.

Body whorl elongate and gently rounded, constituting about one-third to half height of shell. Inner lip and columella flattened and slightly twisted, bounded adapically by a spiral cord.

Aperture elongate-oval, outer lip margin sinuous, definite siphonal canal lacking. Suture distinct, linear. Growth line gently curved, opisthocline, varies in prominence from slightly raised above shell surface (Pl. 16, fig. 23) to forms in which it forms prominent growth rugae (Pl. 16, fig. 24; Pl. 17, figs. 1-3). Oblique color bands (probably reflecting original coloration or differences in shell micro-structure) present on some well-preserved shells.

Type species. — *Ewekoroia nigeriensis* Adegoke, new species.

Remarks. — The diagnostic features of the new genus are its high spire, the gently convex whorls, the peculiar growth lines, the oblique axial bands, and the twisted columella bounded by a spiral cord.

Superficially, the new genus shows certain features reminiscent of those of members of the families Terebridae (*e.g. Terebra*), Epitoniidae (*e.g. Acirsa,* Furon, 1948, p. 105), Melanellidae (*e.g. Melanella* = *Eulima,* Bartsch, 1917), and Turritellidae (*e.g. Mesalia vetusta* Conrad). It is readily distinguished from these by its size, the apertural characters, especially the twisted columella, the absence of a definitive siphonal canal, and the peculiar growth lines which tend to be elevated to form growth rugae.

Representatives of the new genus were first recorded from Togo by Furon (1948), who mistakenly assigned them to *Mesalia* (*Mesalia*? *acirsoides* Furon, 1948, p. 105, pl. 9, fig. 3). He emphasized the *Acirsa*-like external features (especially the growth lines) of the species though he assigned it questionably to *Mesalia* because of the columellar features. He noted further that the absence of spiral sculpture precludes assignment to *Mesalia sensu stricto.*

Closer study of several, well-preserved specimens shows that not only the growth lines but also the columellar fold are unlike those of *Mesalia.* Additionally, the tendency to develop growth rugae (which are accentuations of the growth line features) and the attendant oblique axial color banding which reaches a climax in *Ewekoroia rugifera* Adegoke, new species, remove the new genus from inclusion in the family Turritellidae.

Ewekoroia nigeriensis Adegoke, new species Pl. 16, figs. 16-22

Description. — Shell medium-sized, with high spire which is gently and uniformly tapered. Spire consists in the adult of about a dozen whorls the first three of which are convex and subsequent ones more or less flat-sided, apical angle about 23°.

Body whorl relatively high, constituting about two-fifths height of shell, gently convex and slightly inflated above the aperture, and sloping gradually anteriorly at an angle of about 45°.

Suture linear, slightly channelled. Aperture variable, more or less oval to subquadrate. Columellar lip flattened, twisted and bounded near the adapical margin by a well-defined spiral cord which originates on the adapical wall of the columella. Growth line sinuous, strongly opisthocline, producing a negative growth line angle. Growth lines striate not elevated to form rugae; axial "color" bands occur between the growth line striae.

Material. — Eighteen nearly complete specimens.

Types. — Holotype, UIMG No. 242; paratypes UIMG Nos. 243-245, USNM, Nos. 174784-174785, PRI 29783.

Dimensions (mm). —

	height	maximum diameter
UIMG 242	33.55	9.30
UIMG 243	22.35	7.40
UIMG 244	39.90	10.75
UIMG 245	24.00	8.15
USNM 174784	31.70	10.20
USNM 174785	30.60	8.75

Remarks. — This species attains the largest adult size among the three species here referred to *Ewekoroia*. It is characterized by its high, acutely tapered shell, the elongate body whorl with an average height to diameter ratio of 1.65 (range 1.5 to 1.8), and the twisted columella with spiral cord. The columellar plication originates on the adapical columellar wall and is thus, not comparable with the median "entering spiral ridge" of *Mesalia* (Marwick, 1957, p. 162, fig. 67).

Ewekoroia nigeriensis may be distinguished from other species in the genus by its more elongate slender shell, the more prominently flattened and twisted columella, and the absence of growth rugae, the shell being more or less smooth.

Ewekoroia acirsoides (Furon) Pl. 16, figs. 23-28

Mesalia(?) *acirsoides* Furon, 1948, p. 105, pl. 9, fig. 3.

Description. — Shell small, spire moderately high, and with non-uniform taper; earliest apical whorls narrow and gently tapering, later whorls increase in diameter abruptly thereafter increasing only gently (Pl. 16, figs. 26, 27), thus producing a stubby spire crowned by a narrow apical cone; pleural angle about 25° to 27°. Spire whorls gently inflated in the middle, flattened at the ends, with a slight adapical shoulder which is noded. Below the shoulder, shell is weakly excavated, then convex.

Body whorl moderately elongate and moderately robust. Columella short and twisted with a faint spiral cord which is further obliterated by a moderately thick parietal callus. Growth lines produce weak nodes where they intersect the adapical shoulder; growth line trace slightly curved, gently opisthocline, producing a negative growth line angle. On adult whorls, growth rugae are formed in the adapical edge of each whorl. Suture distinct, impressed, slightly oblique; aperture hemispherical.

Material. — Twenty-four specimens with most of the apical whorls missing.

Types. — Hypotypes, UIMG Nos. 246-249, USNM Nos. 174786-174787, PRI Nos. 29788, 29789.

Dimensions (mm). —

	height	maximum diameter
UIMG 246	20.65	7.50
UIMG 247	21.55	8.85
UIMG 248	21.10	8.00
UIMG 249 (incomplete)	22.75	7.10
USNM 174786	21.65	8.45
USNM 174787 (incomplete)	24.50	9.75

Remarks. — This species was only briefly described and poorly figured by Furon (*op. cit.*) who assigned it questionably to *Mesalia*. It differs from *Ewekoroia nigeriensis* Adegoke, new species, by its more prominent and flatter growth lines which tend to form growth rugae in the adapical half of the whorl, the slightly angulated and noded apical whorl rim, the wider but shorter aperture, the parietal callosity, and the more obtuse spire.

It may be distinguished from *E. rugifera,* new species, by its more arcuate and more opisthocline growth lines which are less completely raised to form growth rugae.

Ewekoroia rugifera Adegoke, new species Pl. 17, figs. 1-3

Description. — Shell small, spire moderately high, consisting of about seven to eight flat-sided whorls which increase uniformly in diameter as added. Protoconch not preserved. Earliest post-nuclear whorls smooth and gently convex. Suture distinct, impressed, with a slight shoulder.

Body whorl moderately high. Whorls ornamented by several evenly elevated growth rugae separated by slightly narrower interspaces. Growth rugae only gently arched, straight to slightly opisthocline, with the adapical end more prominently elevated. About 25 rugae present on adult body whorl. Aperture narrow, slightly oval. Columella short, siphonal fasciole not prominent.

Material. — Two specimens.

Types. — Holotype, UIMG No. 250; paratype, USNM No. 174788.

Dimensions (mm). —

	height	maximum diameter
UIMG 250	18.35	5.95
USNM 174788	17.25	7.35

Remarks. — This species is erected for specimens of *Ewekoroia* which show complete and maximum development of growth rugae. The rugae are even-sized and are separated by subequal interspaces which are slightly narrower than the rugae. The species, thus, differs from the other members of the genus in the complete elevation of growth rugae in all but the earliest whorls. It differs further by its straighter growth lines, the shorter and more oval aperture and the less prominently twisted anterior edge of the columella.

The trend from smooth shells with arched growth striae in

Ewekoroia nigeriensis Adegoke, new species, through the partially rugose shells of *E. acirsoides* (Furon) to the completely rugose shells with straight growth lines of *E. rugifera* Adegoke, new species, is suggestive of a gradual and progressive evolutionary change. The difficulty of collecting stratigraphically controlled samples (see Fauna) prevents conclusive demonstration of a vertical (temporal) appearance of these morphologic forms.

Family **VERMETIDAE** Gray, 1828

Genus **VERMETUS** Daudin, 1800

Subgenus **VERMETUS** sensu stricto

Vermetus (Vermetus) nigeriensis Adegoke, new species

Pl. 17, figs. 13-17

Description. — Shell medium-sized, consisting of an irregularly and loosely coiled portion, followed by an uncoiled, wavy portion. The species occurs in an aggregated mass (Pl. 17, fig. 14) in which specimens grow over one another causing compression and bending of tubes.

Outer surface of individual shell is rugose, coarsely sculptured by growth rugae often developed in a chevron-shaped pattern (Pl. 17, figs. 13, 17). Superimposed on these are a variable number of axial ribs which are uneven in size and prominence (Pl. 17, figs. 15, 16), producing a "reticulate" sculpture. Shell outline sub-polygonal.

Types. — Holotype, UIMG No. 251; paratypes, UIMG No. 252, 253, USNM No. 174789, 174790.

Dimension. — Average diameter of individual tube about 2.5-3.0 mm.

Remarks. — This species resembles the type species of the genus, *Vermetus (Vermetus) adansonii* Daudin, in many of its morphologic features especially its loosely coiled shell and the tendency to occur in aggregated form (Adanson, 1757, pl. 11, fig. 1; Fischer-Piette, 1942, pl. 9; Nicklés, 1950, fig. 62; Keen, 1961, text-figs. 4-7), and the absence of internal spiral laminae (which was erroneously attributed to the type species by Mörch, 1861). It differs by its numerous, uneven axial sculpture, the polygonal outline and the "reticulate" sculpture.

The new species is probably closely related to *Vermetus miniatus* and *Vermetus landanensis* (Vincent, 1913, pl. 1) from Landana.

Both have well-developed axial ribs but the ribs are more even and more regularly developed in the Landana species.

Genus **BURTINELLA** Mörch, 1861

"Burtinella" ewekoroensis Adegoke, new species Pl. 17, figs. 4-9

Description. — Shell small, thin-walled, conical; initial portion not known. Shell is a long, cylindrical, helicoidally coiled tube which forms an umbilicate cone. Coiling regular to irregular, fairly compact at apex, tending to loose coiling in adult, producing an uneven cone. Contact between adjacent whorls occur on less than ¼ of the circumference of shell. Shell outline subcircular.

Umbilicus wide, with steeply sloping wall. Shell smooth, devoid of internal structure.

Material. — Two specimens lacking earliest apical whorls.

Type. — Holotype, UIMG No. 254; paratype, USNM No. 174791.

Dimensions (mm). —

	height	anterior diameter
UIMG 254 (incomplete)	2.15	3.00
USNM 174791 (incomplete)	1.75	3.05

Remarks. — Wenz (1939, p. 677) listed *Burtinella* as a valid molluscan genus within the family Vermetidae. Keen (1961, p. 184) summarily dismissed the usage of *Burtinella* and a few other taxa as valid molluscan names on the basis of the claim that many of their type species have since been shown to include annelids. It has been argued that even if Keen's claim were to be true for the type of *Burtinella* and other affected taxa, there is little doubt that a number of *Burtinella*-like mollusks exist. The invalidity of *Burtinella* would automatically render such mollusks nameless. In order to avoid such chaos and until the taxonomic position of *Burtinella* is properly clarified, the qualified name "*Burtinella*" is utilized here.

"*Burtinella*" *ewekoroensis* Adegoke, new species, differs from "*Burtinella*" *turriformis* Adegoke, new species, by its shorter, more loosely coiled shell, and the wider umbilicus.

"Burtinella" turriformis Adegoke, new species Pl. 17, figs. 10-12

Description. — Shell small, with moderately high spire of more than six-seven whorls. Initial portion not preserved. Shell tightly coiled throughout, varying only slightly in diameter from the apex to the anterior end. Umbilicus narrow and deep, with precipitous wall. Shell smooth, with circular outline, and uniformly increasing diameter.

Material. — One specimen.

Type. — Holotype, UIMG No. 255.

Dimensions. — Height (incomplete) 2.75 mm; anterior diameter 2.25 mm.

Remarks. — This species differs from *"Burtinella" ewekoroensis* Adegoke, new species, by its higher, narrow, tightly coiled shell, the slow taper the uniform tube diameter, and the narrow, deep umbilicus.

Family **CERITHIOPSIDAE** Verrill, 1852

Genus **CERITHIELLA** Verrill, 1852

Subgenus **STILUS** Jeffreys, 1885

Cerithiella (Stilus) nigeriensis Adegoke, new species Pl. 17, figs. 21-24

Description. — Shell small, consisting of a large number of narrow, straight-sided whorls which taper only slightly as added. Apex and early spire whorls unknown. Spire and body whorls beautifully sculptured by a system of equally developed axial and spiral ribs which form even-sized nodes at their intersections, producing a cancellate sculpture. The slightly oblique axial nodes are separated by narrower interspaces. Three rows of noded spirals present on all whorls.

Base smooth, demarcated from rest of body whorl by a prominent basal groove. Columella short and stout, twisted and slightly recurved anteriorly; a spiral ridge marks off the posterior limit of the siphonal canal. Siphonal canal short and wide, recurved. Suture linear, indistinct, slightly channelled. Aperture and siphonal canal narrow, comma-shaped.

Material. — Two incomplete specimens.

Types. — Holotype, UIMG No. 256; paratype, USNM No. 174792.

Dimensions (mm). —

	height	maximum diameter
UIMG 256 (incomplete)	2.55	1.15
USNM 174792 (incomplete)	2.00	1.85

Remarks. — This elegant species is described on the basis of two well-preserved specimens. The holotype, though small is complete but for the apex.

The new species is characterized by the even development of axial and spiral sculpture, the attendant cancellate texture, the twisted columella, and siphonal canal. It resembles in the latter, the American species of *Cerithiella* (Palmer, 1937, pl. 29; Harris, 1899, pl. 9). It differs from them by the cancellate nature of its sculpture and the possession of three noded spiral ribs. The same features also distinguish the new species from the European Eocene *Cerithiella* referred by Cossmann and Pissarro (1910-1913, pls. 26, 27) to the genus *Newtoniella.*

Genus **CERITHIOPSIS** Forbes and Hanley, 1849

Subgenus **CERITHIOPSIS** sensu stricto

Cerithiopsis (Cerithiopsis) adekunbii Adegoke, new species

Pl. 17, figs. 18-20, 25

Description. — Shell small, gently and uniformly tapering. Spire high, with straight-walled whorls which are about twice as wide as they are high. Suture linear, located at the abapical end of the sutural groove.

Body whorl incompletely preserved. Whorls sculptured by noded spiral ribs, nodes slightly longer than wide. Three primary spirals are present on early whorls, the first is close to the adapical edge of whorl, the second is anterior to the midline while the third is separated from the abapical suture by the sutural groove. The first and second spirals are subequal and prominently noded while the third is narrower and remains unnoded throughout ontogeny.

A second spiral appears between the two adapical primaries early in development and is noded from its insertion. It is smaller than the adjacent spirals on most of the spiral whorls. On the adult whorls it rapidly becomes prominent and is subequal to the primaries. Finer threads also appear in the interspaces of adult whorls. Columella straight; aperture small, oval.

Material. — Two incomplete specimens.

Types. — Holotype, UIMG No. 257; paratype, USNM No. 174793.

Dimensions (mm). —

	height	maximum diameter
UIMG 257 (incomplete)	4.50	2.05
USNM 174793 (incomplete)	—	1.45

Remarks. — This elegant species is characterized by its three primary spirals of which the adapical two are noded and the abapical one smooth, and the development of a noded secondary spiral which later rivals the primaries in prominence.

The new species may be distinguished from *Cerithiopsis fagadei* Adegoke, new species by its more numerous spirals, the unnoded abapical primary spiral, and the straighter anterior canal.

Cerithiopsis waneri Oppenheim (1915, p. 46, pl. 3, figs. 9-12) differs from the new species by its more rounded whorls, the more rapid taper, and the more numerous, completely noded spirals.

The new species is named in honor of my wife, Adekunbi Adegoke.

Cerithiopsis (Cerithiopsis) fagadei Adegoke, new species

Pl. 17, figs. 26, 27

Description. — Shell small, moderately tapered. Earliest whorls not preserved. Spire whorls straight-sided, separated by a narrow sutural groove and an incised suture; ornamented by three subequal, equidistant spirals of which the adapical is close to the suture, the second is approximately median and the third is separated from the abapical suture by the sutural groove. Of these, only the adapical spiral is faintly noded. A secondary thread occurs in the interspace between the first and second primaries, and another occurs adapical to the suture.

Body whorl gently convex, sharply constricted at the base and ornamented by six spirals which become slightly reduced in strength abapically. As on spire whorls, only the adapical one is weakly noded. Base ornamented by one fine and one major spiral.

Anterior canal straight, cylindrical, with a short siphonal canal. Aperture subquadrate.

Material. — The species is based on one well-preserved specimen.

Type. — Holotype, UIMG No. 258.

Dimensions. — Height 3.40 mm; maximum diameter 1.40 mm.

Remarks. — This species is characterized by its spiral sculpture of which only the adapical spiral is faintly nodose, the presence of finer threads in the interspaces, and the subquadrate aperture.

The new species is named in honor of Dr. S. O. Fagade, Department of Zoology, University of Ibadan, Nigeria.

Cerithiopsis (?Cerithiopsis) akinjidei Adegoke, new species
Pl. 17, figs. 28, 29

Description. — Shell small, most of spire and part of body whorl missing. Spire probably high and gently tapering. Whorls ornamented by heavily noded axial and spiral ribs. Eleven slightly oblique axial ribs are present and are continuous from whorl to whorl, separated by interspaces which are narrower than the ribs. Two rows of spiral nodes are present per whorl, separated by narrow, shallow grooves; nodes alternate in position in adjacent volutions. Suture linear, indistinct. Aperture not preserved.

Material. — The new species is based on the holotype only.

Type. — Holotype, UIMG No. 259.

Dimensions. — Height (incomplete) 4.50 mm; maximum diameter 2.50 mm.

Remarks. — This species is represented by an incomplete (3½ whorls) specimen. Its characters are, however, sufficiently distinct to merit specific designation.

It is larger than the other cerithiopsids described from Ewekoro, the axial nodes are large and obliquely arranged and there are only two rows of spiral nodes per whorl.

The new species is named in honor of Mr. F. G. Akinjide Ogbe.

Subgenus **CERITHIOPSIDA** Bartsch, 1911

Cerithiopsis (?Cerithiopsida) yoloyei Adegoke, new species
Pl. 17, figs. 30, 31

Description. — Shell small, consisting of over nine whorls which taper gradually. Protoconch and earliest apical whorls not preserved. Youngest preserved whorl smooth, followed by a whorl bearing 11 axial ribs and two faint spirals of which the smaller (adapical one) is located just above the whorl midline. Later spire whorls bear, in addition, a spiral rib at the extreme adapical margin which rapidly becomes prominently elevated. Median spiral suppressed throughout ontogeny. A peribasal thread is visible near the linear suture. Columella short, stout, and straight; aperture trigonal.

Material. — The holotype only.

Type. — Holotype, UIMG No. 260.

Dimensions. — Height 2.45 mm; maximum diameter 1.40 mm.

Remarks. — The subgeneric assignment of this species to Bartsch's *Cerithiopsida* is doubtful. Bartsch (1911, p. 328) studied West American cerithiopsids and erected several subgenera based on the sculpture of the nuclear whorls, a feature rarely preserved on most fossil species. Thus, of the 45 taxa considered in Bartsch's monograph, 20 lacked nuclear whorls and were, thus, not assigned to any subgenus.

The present tentative assignment is based on the facts that the earliest preserved whorl of the new species is smooth, followed by an axially sculptured part bearing two spiral ribs. Should this assignment prove correct, the earliest stratigraphic record of the subgenus would be considerably lowered from Pleistocene (Bartsch, 1191; Wenz, 1940) to Paleocene.

The sculpture of the new species is reminiscent of that of *Tympanotonus funatus* (Mantell) (Cossmann and Pissarro, 1910-1913, pl. 29, fig. 151 bis-7), but it lacks the sinuous growth line and the sinuated labrum of *Tympanotonus*. The new species is named in honor of my friend Dr. V. L. A. Yoloye of the School of Biological Sciences, University of Lagos, Nigeria.

Family **POTAMIDIDAE** H. and A. Adams, 1854

Subfamily **POTAMIDINAE** H. and A. Adams, 1854

Genus **PYRAZUS** Montfort, 1810

Pyrazus nigeriensis Adegoke, new species Pl. 18, figs. 1-4

Description. — Shell large, conical, spire incomplete, probably consists of over seven whorls. Whorls much wider than high; width of penultimate whorl more than three times height; whorl side straight, ornamented by about 14 broadly rounded axial ridges with subequally wide interspaces and about 6 moderately broad and flat-topped spiral ribs separated by subequally wide interspaces.

Spiral suture conspicuously wavy, impressed. Body whorl poorly known mostly from internal casts, low, rounded and sculptured in much the same way as the spire. Base flat, aperture rounded, slightly wider than high. Umbilicus probably present.

Material. — Two nearly complete specimens.

Types. — Holotype, UIMG No. 261; paratype, USNM No. 174794.

Dimensions (mm). —

	height	maximum diameter
UIMG 261	50.9	30.6
USNM 174794	30.3	22.3

Remarks. — This species is represented in my collection by two imperfectly preserved specimens of which the holotype is probably an adult. Though incomplete, the preserved morphologic features show that they are distinct from *Pyrazus coloi* Salvan, 1954, the only species of the genus so far recorded from West Africa. The Nigerian material attains a larger adult size, with a larger number of broader axial ridges but fewer spiral ribs than the Maroc species.

Pyrazus expansus Douvillé (1928) is much larger and tapers more sharply than the new species. It also differs in the nature of their spiral sculpture, the former bearing three principal spirals.

Genus **POTAMIDES** Brongniart, 1810

Potamides trituberculatus Cox Pl. 14, figs. 18, 21; Pl. 18, figs. 5, 6, 11, 12

Potamides trituberculatus Cox, 1952, p. 50, pl. 5, figs. 6, 7.

Description. — Shell small, turritelliform; spire high, apical angle about 30°. Whorls convex, ornamented by three prominent spirals which are evenly spaced on the whorls, a fourth but faint spiral occurs adjacent to the suture. Growth line sinuous, conspicuous (Pl. 18, figs. 5, 6, 12), produces tiny nodes where it intersects the spirals. Suture depressed; aperture small and rounded.

Material. — Twenty-two well-preserved and many fragmentary specimens.

Types. — Hypotypes, UIMG Nos. 262-264, USNM Nos. 174795-174797.

Dimensions (mm). —

	height	maximum diameter
UIMG 262	3.85	1.75
UIMG 263	5.50	2.45
UIMG 264	3.80	1.55
USNM 174795 (incomplete)	4.00	2.35
USNM 174796 (incomplete)	9.95	4.70
USNM 174797 (incomplete)	4.35	2.80

Remarks. — This species is similar to the Togolese Paleocene *Potamides* described as *Mathilda togoensis* by Furon (1948, p. 105). As mentioned by Cox (1952), the only distinguishing feature between both is that the spirals are closer placed near the middle of the whorl in *Potamides togoensis*.

The growth line pattern and sculpture of the Nigerian specimens are identical with those of the Ghana and Togolese species, though Furon's illustration makes closer comparison with the Togolese material difficult. The Nigerian specimens differ from Cox's illustrated specimens in that the adapical spiral of the former is less prominently developed than the two abapical spirals.

The species is here considered highly variable, hence Cox's name is applied to all the varieties.

Though the sculpture within this group is reminiscent of those of some Mathildas, the absence of a deviated or submerged to heterostrophic protoconch prevents their inclusion within *Mathilda* (Semper, 1865; Grant and Gale, 1932; Davies, 1935).

Family **PLANAXIDAE**

Genus **PLANAXIS** Lamarck, 1822

Planaxis africana Adegoke, new species Pl. 18, figs. 7-10, 13

Description. — Shell small, consisting of about five whorls which increase rapidly in diameter as added. Spire moderately high, consisting of four rounded, low whorls. Suture distinct, gently channelled. Body whorl high, constituting about two-thirds height of shell, gently convex adapically and inflated at the base, ornamented by numerous fine, closely spaced spiral threads. Aperture quadrate. Anterior canal stout, wedge-shaped, tapering to a pointed anterior end. Siphonal canal short, slightly recurved.

Material. — Five well-preserved specimens.

Types. — Holotype, UIMG No. 265; paratypes, UIMG Nos. 266, 267, USNM Nos. 174798, 174799.

Dimensions (mm). —

	height	maximum diameter
UIMG 265	1.85	1.30
UIMG 266	2.25	1.50
UIMG 267	1.85	1.50
USNM 174798	2.55	1.65
USNM 174799	1.55	1.40

Remarks. — This species is characterized by its small size, the high apical angle, the slight basal inflation of the body whorl, the quadrate aperture, and the sculpture consisting of several fine threads (Pl. 18, fig. 8).

It most closely resembles *Planaxis breviculus* Cossmann (Cossmann and Pissarro, 1910-1913, pl. 23: fig. 135-5) from the Sparnacian of the Paris Basin. The Nigerian species is smaller and has a more quadrate body whorl and aperture.

Family **ARCHITECTONICIDAE** Gray, 1850

Genus **PSEUDOMALAXIS** Fischer, 1885

Subgenus **NIGERIALAXIS** Adegoke, new subgenus

Diagnosis. — Minute to medium-sized *Pseudomalaxis,* with apical surface ranging from gently concave through flat to gently convex. Protoconch and nuclear whorl moderate to highly inflated, later whorls flattened apically, smooth to highly ornate; whorls angulated on umbilical surface. An apical keel surrounds the apical margin and one or more spirals present on the periphery of final whorl causing a slight to pronounced angulation. Umbilicus wide with earliest whorls mostly visible; aperture subtrigonal to subrounded.

Type species. — *Pseudomalaxis (Nigerialaxis) fayosei* Adegoke, new species.

Remarks. — Four determinate and one indeterminate species from the Ewekoro quarry are here assigned to the new subgenus. Their morphologic features distinguish them from previously described subgenera of *Pseudomalaxis* (Fischer, 1885; Monterosato, 1913; Rehder, 1935). Also included in the new subgenus is the Togolese species, *Pseudomalaxis parisoti* Furon (1948).

Nigerialaxis, new subgenus, may be readily distinguished from *Ewekorolaxis,* new subgenus, by the presence of the heavy peripheral spiral band(s), the subtrigonal aperture, and the highly ornate shell; and from *Platylaxis,* new subgenus, by its more inflated and more ornate test.

Pseudomalaxis (Nigerialaxis) fayosei Adegoke, new species
Pl. 18, figs. 14-16

Pseudomalaxis, n. sp. Adegoke, 1972a, pl. 3, fig. 8.

Description. — Shell medium-sized, biconcave, consists of about 5½ whorls. Apical surface gently concave, umbilical surface deeply concave. Protoconch fairly large, inflated and smooth, followed by a smooth and gently rounded nuclear chamber of about 1¼ whorls. Later whorls bear four noded spirals of which the abapical, which is the first to appear is the heaviest. The adapical two spirals are subequal and more prominently noded than the others. Suture distinct, narrow, and deeply channelled.

Umbilicus wide, deep, with steplike walls (Pl. 18, fig. 16); each whorl bears on the umbilical surface three spirals of which the adapical one is located some distance about the suture; the second is approximately median, and the third is located near the umbilical rim; each is prominently elevated and noded.

The peripheral wall of the final volution bears a heavy keel-like spiral near the apical margin (Pl. 18, fig. 15), separated from the noded apical spiral by a shallow, concave groove. Between this lateral keel and the umbilical spiral, the wall is gently convex and bears three subdued spirals with faint threads in the interspaces; wall also sculptured by prominent growth lines.

Material. — The new species is based on the holotype only.

Type. — Holotype, UIMG No. 147.

Dimensions (mm). — Height 3.9 mm.; maximum diameter 11.45 mm.

Remarks. — This new species differs from *Pseudomalaxis parisoti* Furon (1948, p. 103, pl. 8, fig. 20), the only *Pseudomalaxis* known to date from the West African Tertiary, by its narrow, deeply channelled suture, and the more numerous, nodose spiral ribs (four per whorl on the apical surface of the new species, two in *P. parisoti*).

Pseudomalaxis (Nigerialaxis) kayodei Adegoke, new species, has a more bulbous protoconch and nuclear whorl, and a finer reticulate sculpture; *P. (Nigerialaxis) africana* Adegoke, new species, is relatively smoother with a polygonal whorl outline; *P. (Ewekorolaxis) ewekoroensis* Adegoke, new subgenus, new species, has a more bulbous protoconch, and a rounded whorl profile ornamented by concentric threads only; and *P. (Platylaxis) nigeriensis* Adegoke, new subgenus, new species, is flatter, with a narrower umbilicus.

The new species is named in honor of Dr. E. A. Fayose, Department of Geology, University of Ibadan, Nigeria.

Pseudomalaxis (Nigerialaxis) kayodei Adegoke, new species
Pl. 18, figs. 17-19

Description. — Shell small-sized, consisting in the adult of about 3½ to 4 whorls. Protoconch and nuclear whorl large, smooth, highly inflated, and prominently elevated above the gently convex apical surface. Postembryonic whorls become progressively flattened and highly ornate. Apical sculpture consists of three closely spaced spirals situated near the abapical margin of the whorls. The inner (adapical) margin is flattened and devoid of prominent spirals in the earliest two postnuclear volutions, thereafter bearing four fine threads as the growth line striations assume greater prominence (Pl. 18, fig. 18). Suture fine, incised.

Umbilicus wide and deep, bordered by a sharply elevated noded spiral located medianly on the whorl and below which the wall slopes gently at an angle of about 45°. Umbilical surface reticulately sculptured by nodulated axial and spiral ribs. Lateral wall of final whorl sculptured. A deep groove separates the keel-like apical band from a series of five noded spiral ribs (Pl. 18, fig. 19).

Exterior apertural outline subquadrate; apertural opening subrounded.

Material. — Two well-preserved specimens.

Types. — Holotype, UIMG No. 268; paratype, USNM No. 174800.

Dimensions (mm). —

	height	maximum diameter
UIMG 268	1.05	3.15
USNM 174800	1.00	3.20

Remarks. — This species is characterized by its small size, the reticulate ornamentation and the inflated, prominently elevated nuclear whorl. It may be readily distinguished from the much larger, *P. fayosei* Adegoke, new species by the more prominent keel-like development of the spiral band around the apical margin and the deep trough abapical to it, as well as the more prominent median keel on the umbilical surface.

The new species resembles *P. parisoti* Furon in the development of a peripheral keel but differs in having three prominent apical spirals instead of one on the Togolese species. It is further distinguished by its inflated protoconch and embryonic whorl and the fine reticulate sculpture.

It differs from the imperfectly known species described below as *Pseudomalaxis (Nigerialaxis)* sp. A in the details of its apical sculpture.

The new species is named in honor of Prof. A. A. Kayode, Department of Geology, University of Ife, Ile-Ife, Nigeria.

Pseudomalaxis (Nigerialaxis) parisoti Furon Pl. 18, figs. 21-24

Pseudomalaxis Parisoti Furon, 1948. p. 103, pl. 8, fig. 20.

Description. — Shell minute, consisting in the adult of about four-five whorls. Apical surface flat to gently convex. Protoconch not preserved. Later whorls flattened, bounded near the abapical margin by a prominently raised, broad spiral ridge. Apical surface otherwise smooth.

Umbilicus wide, shallow, with smooth wall. Whorl slopes gently from the median crest at an angle of about 45°. Aperture low, trigonal.

Material. — Two specimens.

Types. — Hypotypes, UIMG No. 269, USNM No. 174801.

Dimensions (mm). —

	height	maximum diameter
UIMG 269	1.00	3.45
USNM 174801	0.55	2.05

Remarks. — This species, which was only briefly described and inadequately illustrated by Furon (1948), is represented in my collection by two specimens. Both lack the protoconch and nuclear whorl. The possession of the keel-like apical spiral band separated by a groove from the lateral spiral (Pl. 18, figs. 21, 23) justifies the inclusion of the species in the new subgenus *Nigerialaxis*. In this species the lateral band is sharply elevated, hence both bands are visible on the apical view (Pl. 18, fig. 23).

The smooth walls of *P. (N.) parisoti* serve to distinguish it from the ornate species described here.

Pseudomalaxis (Nigerialaxis) africana Adegoke, new species
Pl. 18, figs. 25-29

Description. — Shell small, suborbicular, consisting of only 3-3½ whorls. Whorl rapidly expands in diameter. Protoconch moderately small, rounded; nuclear whorl rounded and smooth; later whorls become more convexly arched and are separated by a distinctly channelled suture. Apical surface ornamented by a moderately raised spiral band occupying a median position, separated by a wide, excavated area from the marginal rim (Pl. 18, fig. 26).

Umbilicus moderately narrow and deep; umbilical wall ornamented by four subequal, equidistant spirals separated from one another by concave interspaces. Peripheral wall of final whorl convex, ornamented by three prominently raised spirals (Pl. 18, fig. 29) which are more prominent than the apical and umbilical bands. Aperture rounded, slightly compressed.

Material. — Three specimens.

Types. — Holotype, UIMG No. 270; paratype, UIMG No. 271, USNM No. 174802.

Dimensions (mm). —

	height	maximum diameter
UIMG 270	0.85	1.90
UIMG 271	—	1.40
USNM 174802	0.75	1.85

Remarks. — This species is unique in that its sculpture consists of prominently raised spirals only. It is assigned to *Nigerialaxis* Adegoke, new subgenus, because, like the others, it has the apical and lateral spiral bands.

Pseudomalaxis (Nigerialaxis) sp. A Pl. 18, figs. 30, 31

Remarks. — A single fragment of a *Pseudomalaxis,* probably representing a new species, was collected at Ewekoro. The apical surface is flattish, sculptured by a weak adapical ridge and a more prominent, broad band near the abapical margin. The entire surface is sculptured by several equidistant radial riblets.

The umbilicus is wide and shallow, bounded by a prominent ridge (Pl. 18, fig. 30). The peripheral wall bears the keel-like spiral ridge that is characteristic of the subgenus. Between the lateral spiral and the umbilical ridge, the wall slopes gently as in *P. (N.) parisoti* Furon but bears a prominent spiral near the umbilical rim and faint threads in the interspace. It differs from *P. (N.) kayodei* Adegoke, new species, in having only a single spiral rib near the abapical margin on the apical surface (Pl. 18, fig. 31).

Illustrated specimen. — UIMG No. 272.

Subgenus **EWEKOROLAXIS** Adegoke, new subgenus

Diagnosis. — Minute *Pseudomalaxis* with few (two-three) adult whorls; characterized by a highly inflated, smooth protoconch, and nuclear whorl. Later whorls strongly convex to gently flattened on the apical surface. Umbilicus wide and deep, partly exposing most of the earlier whorls. Whorls have a subrounded profile, sculptured by several fine, closely spaced spiral threads.

Type species. — *Pseudomalaxis (Ewekorolaxis) ewekoroensis* Adegoke, new species.

Pseudomalaxis (Ewekorolaxis) ewekoroensis Adegoke, new species
Pl. 18, fig. 20; Pl. 19, figs. 1-6

Description. — Shell minute, suborbicular, consists in the adult of about 2½-3 whorls. Protoconch large, inflated, and smooth. Nuclear whorl also inflated and smooth, exact limit not known. Later whorls remain strongly convex or at best gently flattened. Apical surface gently convex. Sutures channelled.

Umbilicus wide, shallow, exposing variable proportions of earliest whorls. Whorl profile gently and uniformly convex. Shell faintly sculptured by numerous, closely spaced spiral threads, crossed by growth line striae. Aperture compressed, subquadrate to subrounded.

Material. — Four minute but well-preserved specimens.

Types. — Holotype, UIMG No. 273; paratypes, UIMG No. 274; USNM Nos. 174803, 174804.

Dimensions (mm). —

	height	maximum diameter
UIMG 273	0.60	2.15
UIMG 274	1.05	2.20
USNM 174803	0.65	2.40
USNM 174804	0.65	1.60

Remarks. — This is the only species presently known for the new subgenus. It is characterized by its gently convex whorls, the subquadrate outline, and the sculpture consisting of fine spiral threads only.

Subgenus **PLATYLAXIS** Adegoke, new subgenus

Diagnosis. — Minute, flat, and disc-shaped *Pseudomalaxis;* apical surface smooth and gently convex, flattened; umbilical surface also smooth and gently convex. Protoconch moderately small, inflated, later whorls flattened. Umbilicus wide in young, becoming progressively narrower on adult whorls with heavily noded rim and steep walls which conceal most of the earlier whorls. Aperture slitlike.

Type species. — *Pseudomalaxis (Platylaxis) nigeriensis* Adegoke, new species.

Pseudomalaxis (Platylaxis) nigeriensis Adegoke, new species

Pl. 19, figs. 7-12

Description. — Shell minute, lenticular and thin. Protoconch and nuclear whorls poorly preserved, protoconch moderately small, gently inflated; later whorls conspicuously flattened. Apical surface gently convex, smooth, outermost whorl covers up preceding whorls. Peripheral keel-like spiral moderately developed (Pl. 19, fig. 10). Umbilicus narrow, with steep wall, bounded by a coarsely noded rim. Aperture compressed, long and almost slitlike (Pl. 19, fig. 9).

Material. — Eighteen mostly worn specimens.

Types. — Holotype, UIMG No. 275; paratypes, UIMG Nos. 276-277, USNM 174805-174806, PRI Nos. 29790, 29791.

Dimensions (mm).—

	height	maximum diameter
UIMG 275	0.65	1.80
UIMG 276	0.65	1.90
UIMG 277	0.70	2.15
USNM 174805	0.80	2.40
USNM 174806	0.90	2.65

Remarks.—The characteristic features of the new species are its extremely flattened discoidal and smooth shell, the narrow, deep umbilicus bounded by a coarsely noded rim, the compressed final whorl, and the slitlike aperture.

The species resembles species of the subgenus *Nigerialaxis* in the possession of a marginal keel-like spiral. Its other features, especially the flattened shell the absence of spiral sculpture distinguish it from species of *Nigerialaxis*.

Genus **ARCHITECTONICA** Röding, 1798

Architectonica asseezi Adegoke, new species Pl. 19, figs. 13-15

?*Solarium* sp. Oppenheim, 1915, p. 37.

Description.—Shell medium-sized, conical, with moderately elevated spire consisting of about six whorls. Protoconch small, earliest whorls smooth and flat apically, later whorls including body whorl convex adapically, slightly excavated abapically. Suture appressed.

Base concavo-convex, strongly convex around the umbilicus, excavated near peripheral margin. Keel-like structure occurs around periphery. Umbilicus wide and deep, umbilical rim overhangs the umbilicus and is moderately nodulated. Aperture low, subtrigonal. Growth striae distinct over entire shell. Shell smooth but for growth striae.

Material.—Two specimens.

Types.—Holotype, UIMG No. 278; paratype, USNM No. 174807.

Dimensions (mm).—

	height	maximum diameter
UIMG 278	8.60	18.05
USNM 174807	6.30	14.25

Remarks. — This species is similar and probably related to the Togolese species described as *Solarium togoense* by Furon (1948, p. 103, pl. 8, fig. 19). The latter was only briefly described by Furon and was also inadequately illustrated. They differ in the excavated adapical margin of the whorl of the new species, its concavo-convex base, the presence of a marginal keel, and a coarsely noded umbilical rim.

The new species differs from *Solarium patulum* Lamarck and *S. patulum infraeocaenica* Cossmann, from the Lutetian and Cuisian respectively of the Paris Basin (Cossmann and Pissarro, 1910-1913, pl. 16: figs. 104-3, 104-3[1]), by its appressed spiral suture and the coarser granulation of the umbilical rim.

From *S. subpatulum* Oppenheim (1906), from the Mokattam Series of Egypt, the new species may be distinguished by its single marginal keel and the coarser umbilical rim.

The Togolese specimen referred to *Solarium* sp. by Oppenheim (1915) may belong to this species.

The new species is named in honor of Dr. L. O. Asseez, Department of Geology, University of Ibadan, Ibaden, Nigeria.

Architectonica nigeriensis Adegoke, new species Pl. 19, figs. 16-20

Description. — Shell small, conical, with compressed spire, protoconch not preserved. Spire consists of about five whorls; earlier whorls flat on the apical surface, sculptured by a single, raised spiral ridge located near the abapical margin of the whorls. This keel bears a feeble median groove on the last 1¼ adult whorls and is granulate. Whorls ornamented by six weak spirals located in the adapical half of whorls.

Base convex, umbilical margin higher than peripheral margin with a marginal keel separated from the base by a shallow groove. Umbilical rim unevenly serrated. Suture depressed. Aperture subtrigonal. Growth lines cause weak nodules where they intersect spiral sculpture.

Material. — Two nearly complete specimens.

Types. — Holotype, UIMG No. 279; paratype, USNM No. 174808.

Dimensions (mm). —

	height	maximum diameter
UIMG 279	5.70	12.05
USNM 174808	3.85	10.40

Remarks. — The diagnostic features of this species are the compressed spire, the abapical marginal ridge, the bifid peripheral keel, and the faint spiral sculpture. These features distinguish the new species from *Architectonica asseezi* Adegoke, new species, and *A. togoensis* Furon.

The new species resembles *Solarium bisulcatum* von Koenen (1885) from the Paleocene of Copenhagen in the possession of spiral ribs on the apical surface. It differs in the details of spiral sculpture, the trigonal aperture, and the possession of a narrower, steeper walled umbilicus with a less prominently noded rim.

Architectonica sp. A Pl. 19, fig. 21

Remarks. — A fragmentary specimen of *Architectonica* consisting of much of the spire and part of the body whorl was collected from Ewekoro. The whorls are convex and slightly angulated near the adapical third. The sutures are channelled. Each whorl is ornamented by eight subequal spirals which are weakly hatched by the faint growth striae. The protoconch is large, bulbous, and smooth. The umbilicus is wide and deep. Eight spiral ribs are also present per whorl.

This incomplete specimen is unlike any of the species described above and may represent a new species.

Illustrated specimen. — UIMG No. 280.

Superfamily **PYRAMIDELLACEA** d'Orbigny, 1840

Family **PYRAMIDELLIDAE** d'Orbigny, 1840

Genus **ODOSTOMIA** Fleming, 1817

Odostomia nigeriensis Adegoke, new species Pl. 19, figs. 24-28

Description. — Shell small, consisting of about seven-eight whorls in the adult. Protoconch large, bulbous, and smooth. Spire moderately high, obtuse, consisting of about 3½-4 high and gently convex whorls. Body whorl high, constituting about half height of shell, gently and uniformly rounded.

Aperture small, with an obliquely elongate, quadrate outline (Pl. 19, fig. 24). Inner lip short, bears a single, prominently raised spiral plication. Suture linear, impressed. Shell smooth.

Material. — Five well-preserved specimens.

Types. — Holotype, UIMG No. 283; paratypes, UIMG Nos. 281, 282, USNM 174809, 174810.

Dimensions (mm). —

	height	maximum diameter
UIMG 281	2.00	1.30
UIMG 282	2.35	1.05
UIMG 283	1.50	0.85
USNM 174809	1.75	—
USNM 174810	1.6	1.0

Remarks. — This small species is characterized by its relatively large spire whorls, the short inner lip, bearing the strong columellar plication, and the smooth shell. It differs from American Tertiary species of *Odostomia* (Palmer, 1937, pl. 7) by its much shorter inner lip and the robust spire. In these features, it more closely resembles the Paleocene Midwayan species, *Odostomia trapaquara* (Harris).

The spire whorls are more robust but less flat-sided and less angulated than *Odostomia pakistani* Eames from the Eocene of Pakistan (Eames, 1952, pl. 1, fig. 35). The new species is also more slender and less prominently tapered than *O. pupaeforme, O. obtusum,* and *O. undiferum* described by von Koenen (1885) from the Paleocene of Copenhagen.

Subgenus **RAVNOSTOMIA** Adegoke, new subgenus

Diagnosis. — Minute *?Odostomia* with ovoid outline, and a moderately short spire of about 3½ whorls. Protoconch consists of about 2½ smooth, convex whorls. Later whorls more or less flat-sided, sculptured by several fine spiral ribs. Aperture wide, rhomboidal. Siphonal canal extremely short, wide and emarginate. Outer-lip also emarginate.

Type species. — *Odostomia? (Ravnostomia) selandica* Ravn (1933, p. 40, pl. 3, figs. 13a-b).

Remarks. — This subgenus is characterized by its minute shell, the few adult whorls, the spiral sculpture, the emarginate apertural features, and the flattened inner lip lacking a columellar plication. Because of the latter feature, the subgenus is only doubtfully assigned to *Odostomia.* The type species, *Odostomia*? *selandica* was reported by Ravn from the Calcaire de Faxe.

The new subgenus differs from *Odostomia (Brachystomia)* Monterosato, 1885 (Wenz, 1940, p. 855) by the fewer spire whorls which taper more uniformly, the emarginate aperture, the strong spiral sculpture, and the absence of columellar plication.

The new subgenus is named in honor of Dr. J. P. J. Ravn.

Odostomia? (Ravnostomia) rosenkrantzi Adegoke, new species
Pl. 19, figs. 29, 30

Description. — Shell minute, consisting in the adult of about five-six whorls. Nuclear whorls rounded, smooth, consisting of about 2½ whorls. Post-nuclear whorls large, flat-sided or only gently convex, ornamented by several fine spiral ribs separated by narrow, linear interspaces. About 11 spirals present on spire whorls, of which the adapical is more prominent and wider than succeeding ones. Thirteen spirals present on the upper body whorl. Base similarly sculptured by about 18 fine threads.

Aperture relatively wide, oval-rhomboidal. Anterior canal short and wide, lip emarginate.

Material. — One well-preserved ornate specimen.

Type. — Holotype, UIMG No. 284.

Dimensions. — Height 2.8 mm; maximum diameter 1.6 mm.

Remarks. — This elegant species is characterized by its short, emarginate anterior canal, the smooth nuclear whorls of about 2½ volutions, and the numerous, closely set spiral ornamentation.

It resembles the type species for the new subgenus, *Odostomia*? *(Ravnostomia) selandica* Ravn, but may be distinguished by its less emarginate lip, the flatter penultimate and body whorls, and the more numerous spiral sculpture (11 on the spire whorls of the new species, six on Ravn's species).

The new species is named in honor of Dr. A. Rosenkrantz.

Genus **SYRNOLA** A. Adams, 1860

Syrnola isiakae Adegoke, new species Pl. 19, figs. 31-34

Description. — Shell small, elongate, and bluntly tapering.

Spire high, consisting of about five high and gently convex whorls. Protoconch smooth and inflated, earliest post-protoconch whorls increase in diameter rapidly, later whorls of subuniform diameter. Body whorl high, narrow, constituting about half entire height of shell. Aperture small, oblong-oval. Columella short, bearing a strong plication. Outer lip moderately thick. Shell completely smooth.

Material. — The new species is based on two specimens.

Types. — Holotype, UIMG No. 285; paratype, USNM No. 174811.

Dimensions (mm). —

	height	maximum diameter
UIMG 285	2.3	0.9
USNM 174811 (incomplete)	2.5	1.3

Remarks. — This species is based on two well-preserved specimens of which the holotype is complete. The species resembles *Syrnola propeacicula* Cossmann (1893, 1921; see also Palmer, 1937, p. 79, pl. 7, figs. 1-3, 10, 11), but it has a higher body whorl and a more slender apex.

The new species is named in honor of Mr. Isiaka, Works Chemist, West African Portland Cement Company Ltd., Ewekoro.

Superfamily **CALYPTRAEACEA** Blainville, 1824

Family **HIPPONICIDAE**

Genus **HIPPONIX** Defrance, 1819

Hipponix sp. aff. **H. demissus** Cox Pl. 19, figs. 35-37

Type. — Hypotype, UIMG No. 286.

Remarks. — A small internal cast of a cap-shaped *Hipponix* was collected at Ewekoro. It has a median crest from which the lateral walls slope uniformly. The shell is more narrowly tapered posteriorly and the base has an elongate-oval outline and is convex. Details of exterior sculpture was not preserved.

This species differs significantly from the type of *Hipponix demissus* Cox (1952, p. 47, pl. 5, figs. 2a, b), the only species yet recorded from the West African Tertiary. The anterior is broader with a sub-vertical wall, the postero-dorsal profile is less convex and the posterior margin narrower. Inasmuch as the Nigerian material is an internal cast, it cannot be definitely assigned to a different species. Resolution of the specific position of the Nigerian material must await the collection of more completely preserved material.

Family **CALYPTRAEIDAE** Blainville, 1824

Genus **CALYPTRAEA** Lamarck, 1799

Calyptraea nigeriensis Adegoke, new species Pl. 20, figs. 1-5

Description. — Small to medium-sized *Calyptraea*. Shell wide, low, with subcircular outline. Spire prominently elevated, eccentric, consisting of about 2½ smooth whorls. Protoconch small.

Body whorl flares out rapidly but is low, diameter to height ratio is about 4:1, sides gently convex. Ornamentation consists of a series of oblique grooves, ridges and mammillae. On the large adult shell, four axial ridges occur between adjacent mammillae. The mammillae form short, hollow prominences on the shell surface (Pl. 20, fig. 1). Base uneven, elevated near the inner lip, with a funnel-shaped depression leading into the narrow, deep, umbilicus. Aperture elongate, hemispherical.

Material. — Ten specimens of which only one is fully grown.

Types. — Holotype, UIMG No. 287; paratypes, UIMG 288, USNM 174812.

Dimensions (mm). —

	height	maximum diameter
UIMG 287	9.2	30.0
UIMG 288	2.3	5.0+
USNM 174812	1.3	3.7

Remarks. — This species, represented in my collection by one adult and nine immature specimens, is characterized by its flattened shell, the elongate-oval aperture and the sculpture consisting of mammillae alternating with unevenly developed rows of axial ridges and grooves.

The new species differs from *Calyptraea aperta* Solander and *C. pectinata* Mayer-Eymar by its low, flatter shell, the peculiar sculpture, and the lenticular aperture. It may also be readily distinguished from *C. sigaretina* Oppenheim (1904) from the Eocene of the Cameroons by its flatter, larger shell, the exterior sculpture, and the more eccentric apex.

Calyptraea ewekoroensis Adegoke, new species Pl. 20, figs. 6-8

Description. — Shell small to medium, high, with subcircular outline. Protoconch small, spire moderately high, consists of about 1½ smooth whorls; suture distinct, slightly impressed.

Body whorl enlarges in diameter and height markedly, diameter to height ratio about 2 to 1; wall convex, sloping gently to the ventral margin. Surface ornamented by a system of slanting, coarse, axial ridges and hollow mammillae, about five axial ridges present between adjacent mammillae. Ventral surface not preserved on the adult specimen studied; depressed in young shell, with a prominent columella and a narrow umbilicus. Aperture with an elongate triangular outline.

Material. — Four mostly minute specimens.

Types. — Holotype, UIMG No. 289; paratype, USNM No. 174813.

Dimensions (mm). —

	height	maximum diameter
UIMG 289	11.2	20.6
USNM 174813	2.4	5.2

Remarks. — The diagnostic features of this species include its circular outline, the high spire and the sculpture consisting of five ridges between adjacent mammillae. It may be readily distinguished from *Calyptraea nigeriensis* Adegoke, new species, by the above features as well as its more symmetrical apex, the low diameter to height ratio of about 2 to 1 (as compared with 4 to 1 in the latter), and the absence of axial grooves which are prominent features of the exterior sculpture of *C. nigeriensis.*

The new species has a relatively lower spire than *C. sigaretina* Oppenheim, 1904, from the Cameroons, and the sculpture is markedly different from those of *C. aperta* Solander and *C. pectinata* Mayer-Eymar.

Superfamily **STROMBACEA** Rafinesque, 1815

Family **STROMBIDAE** Swainson, 1840

Genus **RIMELLA** Agassiz, 1840

General statements.—There has been much confusion about the generic placement of the West African Tertiary species here referred to *Rimella* Agassiz.

In his original description of *Rimella subhumerosa,* Oppenheim (1915), assigned the species to *Rostellaria (Cyclomolops).* Both Furon (1948) and Tessier (1952) similarly assigned the species to *Cyclomolops* and accorded full generic status to the latter. Cox (1952) referred the species to *Calyptraphorus.*

Assignment of the species to *Cyclomolops* Gabb (1898) is untenable because the West African species all lack the long and straight anterior canal of Gabb's type species, their spires are also shorter, and they lack the vernicose coating on the early whorls. Besides, the thick callosity present on the columellar lip of the West African species does not continue around the anterior end of the aperture to join the callus on the margin of the outer lip as in *Cyclomolops* (Gabb, 1898, p. 142, pl. 13, fig. 4).

Cox's (1952) assignment of the species to *Calyptraphorus* was based solely on the assumption that the absence of anterior siphons in the West African fossil material was a result of poor preservation.

The general characters of the species studied here are closer to those of *Rimella* (Gabb, 1898; Cossmann, 1904; Clark and Palmer, 1927) hence they are here referred to *Rimella.*

Rimella subhumerosa (Oppenheim) Pl. 20, figs. 9-13

Rostellaria (Cyclomolops) subhumerosa Oppenheim, 1915, p. 48 (in part), pl. 4, figs. 2-6, (not figs. 1a, b = *Tibia oppenheimi* Adegoke, new species, which see; not figs. 7a, b = *Rimella ewekoroensis* Adegoke, new species.)—Furon, 1948, pl. 9, fig. 6.
Cyclomolops subhumerosa Oppenheim; Furon, 1948, p. 105; Tessier, 1952, p. 375, pl. 32, fig. 6.
Calyptraphorus subhumerosus (Oppenheim); Cox, 1952, p. 51, pl. 5, figs. 14a-b.

Material.—Over 22 adult and 5 immature specimens.

Types.—Hypotypes, UIMG Nos. 290, 291, USNM Nos. 174814, 174815, PRI Nos. 29792, 29793.

Dimensions (mm).—

	height	maximum diameter
UIMG 290	30.85	15.80
UIMG 291	27.65	14.55
USNM 174814	27.00	13.10
USNM 174815	18.65	10.85

Remarks. — This species, which is widely distributed throughout West Africa, is common at Ewekoro. Over 22 adult specimens were examined. The spire is acute with about eight-nine smooth, straight-sided whorls. The body whorl is large, constituting more than half the height of the shell. It is slightly shouldered near the adapical margin. The outer lip margin is thickened as a result of the deposited callus which continues adapically, widening slightly as it passes the body whorl shoulder, covers the two preceding spire whorls and is sharply flexed back to join the heavy parietal callus (Pl. 20, figs. 10, 12, 13). Posterior canal is narrow, deep and sinuous between the two callosities (Pl. 20, figs. 11, 13).

Rimella subhumerosa is a variable species. Considerable variation was noted in the height of spire, diameter of body whorl, and the prominence of callosities. Despite these, the Nigerian, Ghanaian, Senegalese, and Togolese material are conspecific.

Rimella ewekoroensis Adegoke, new species Pl. 20, figs. 14-20

Rostellaria (Cyclomolops) subhumerosa Oppenheim, 1915, p. 48 (in part), pl. 4, figs. 7, 7a (only).

Description. — Shell small, spire high, consisting of about eight more or less straight-sided, low whorls. Apical angle high, about 40-45°. Body whorl irregular, compressed, constituting about two-thirds height of shell; bears on the abapertural face four narrow and short axial ridges which decrease progressively in size away from the outer lip margin; the prominent elevation of the first of these ridges (Pl. 20, figs. 16, 18) gives the test a strongly compressed form. Apertural surface devoid of nodes.

Outer lip margin thickened by deposition of a thin band of callus which extends obliquely apicalward to cover the penultimate and part of the preceding whorl, it flexes sharply to the right, tapering gradually to a pointed end in the lower third of that whorl (Pl. 20, figs. 14, 19). Columella and inner lip also covered by callosity which extends straight up the spire as a wedge-shaped tongue (Pl. 20, figs. 15, 20). Posterior canal forms a broad, shallow gutter between the two callosities (Pl. 20, fig. 17).

Material. — Fifteen mostly complete specimens.

Types. — Holotype, UIMG No. 292; paratypes, UIMG Nos. 293-294, USNM Nos. 174816-174818, PRI 29815-29817.

Dimensions (mm). —

	height	maximum diameter
UIMG 292	14.2	6.5
UIMG 293	14.1	7.8
UIMG 294	13.7	7.6
USNM 174816	15.5	7.2
USNM 174817	10.5	4.9
USNM 174818	8.5	4.2

Remarks. — This species may be readily distinguished from *Rimella subhumerosa* (Oppenheim) by its much smaller adult size, the presence of four vertical costae on the abapertural face of the body whorl, the more slender shell, and the less prominently developed and narrower apical extension of the parietal callus.

The specimens figured as *R. subhumerosa* by Oppenheim (pl. 4, figs. 7a, b) show the short axial ridges characteristic of this species and are thus included in the new species.

Rimella adekunbiana Adegoke, new species Pl. 20, figs. 21-23

Description. — Shell medium-sized, thin-walled, biconic. Spire high, consisting of about eight or nine gently convex, uniformly tapering whorls which are about twice as wide as high. Protoconch small and rounded. Body whorl high, cylindrical, constituting about 3/5 height of shell, slightly angulated near the adapical margin.

Aperture narrow, elongate oval. Columella stout, conical, not completely preserved, with heavy callus covering the parietal area. Posterior canal narrow, describing a strongly sinuous pattern on the upper body whorl and penultimate whorl. Thin callus deposit lines the floor of the posterior canal. Exterior of the shell smooth with a glossy finish, marked only by faint growth striae.

Material. — The new species is based on two well-preserved specimens.

Types. — Holotype, UIMG No. 295; paratype, USNM No. 174819.

Dimensions (mm). —

	height	maximum diameter
UIMG 295	24.65	10.10
USNM 174819 (incomplete)	16.00	8.80

Remarks. — This new species is characterized by its uniformly cylindrical, non-compressed shell, the narrow, sinuous posterior canal and the moderately developed callosities. These features serve to distinguish it from *R. subhumerosa* (Oppenheim) and the smaller-sized *R. ewekoroensis* Adegoke, new species.

The new species is named in honor of my wife, Adekunbi Adegoke.

Genus **TIBIA** Bolten in Röding, 1798

Subgenus **AMPLOGLADIUS** Cossmann, 1889

Tibia (?Amplogladius) oppenheimi Adegoke, new species

Pl. 20, figs. 24-30

Rostellaria (Cyclomolops) subhumerosa Oppenheim, 1915, p. 48 (in part), pl. 4, figs. 1a, b (only)

Description. — Shell small, spire moderately high, consisting of about five convex whorls which are about twice as wide as high. Body whorl high, quadrangular in shape and inflated, constitutes about 3/5 height of shell, strongly constricted below the aperture leading to the long, narrow anterior canal. Whorls ornamented by several, closely spaced threads, separated by narrow interspaces. Suture incised to narrowly channelled.

Columella long, straight, tapering to a sharp point. Aperture moderately wide, oval, leading to a very long, narrow siphonal canal. Aperture-siphonal canal complex shaped like a bird's beak. Growth lines conspicuous with double sinus.

Material. — The new species is represented by over 25 well-preserved specimens.

Types. — Holotype, UIMG No. 296; paratypes, UIMG Nos. 297-299, USNM Nos. 174820-174822, PRI No. 29794.

Dimensions (mm). —

	height	maximum diameter
UIMG 296	7.45	3.65
UIMG 297	8.35	3.45
UIMG 298	5.55	2.85
UIMG 299	4.70	2.45
USNM 174820	3.90	2.20
USNM 174821	3.85	2.20
USNM 174822	6.35	2.95

Remarks. — The generic affinities of this small but elegant species is not certain. It was figured by Oppenheim (1915, pl. 4, figs. 1a, b) as immature specimens of *Rimella subhumerosa* (Oppenheim). Closer comparison with adults and immature, similar-size classes of the latter species shows gross dissimilarities (compare Pl. 20, fig. 13 with figs. 24-30).

The spire of the new species has fewer, more robust whorls, subtending a greater apical angle than immature and adult specimens of *R. subhumerosa*. Besides, the body whorl is more cylindrical, more inflated, and terminates in the long, beaklike siphonal canal. The spiral ornamentation is distinctive and the absence of the heavy parietal and labral callosities so characteristic of *R. subhumerosa* further justifies separation of the two species and also prevents the inclusion of the new species in the genus *Rimella*.

The new species resembles *Tibia planulata* Bellardi reported by Tessier (1952) from the Lutetian of Senegal but may be readily distinguished by the shorter, more convex spire whorls, the inflated body whorl, the narrower, more elongate anterior canal, and the spiral sculpture.

The new species is named in honor of P. Oppenheim.

Tibia (?) bivarica Adegoke, new species Pl. 19, figs. 22, 23

Description. — Shell small, thin-walled, consisting of probably up to 10 whorls. Protoconch small, smooth, rounded; followed by two convex, smooth post-embryonic whorls; later whorls moderately convex, sculptured by several axial ribs and two prominent varices. First sculptured whorl bears almost twice as many fine, greatly curved axial ridges as later whorls. These axial ridges extend almost as far as the suture.

The two varices are located almost 180° apart, they are discontinuous from whorl to whorl and are prominently displaced in some adjacent whorls (Pl. 19, fig. 22), their ends abut against the suture.

Between 10-16 axial ribs are present between the varices on adult whorls. Whorl surface further sculptured by about 13 faint, flat-topped spiral ribs separated by narrow, linear grooves. Suture deeply incised. Base ornamented by about 10 spiral ribs similar to those on body whorl. Columella elongate, straight, and cylindrical. Outer lip margin not preserved. Aperture hemispherical.

Material. — The new species is based on the holotype only.

Types. — Holotype, UIMG No. 300.

Dimensions. — Height 9.70 mm; maximum diameter 2.9 mm.

Remarks.—This elegant species is characterized by its numerous narrow axial ribs, the development of varices along two planes 180° apart, and the faint, broad spiral ribs.

The doubtful assignment of the species to the family Strombidae is based on its elongate anterior canal, a feature in which it resembles *Tibia (?Amplogladius) oppenheimi* Adegoke, new species. This affinity was kindly pointed out by Dr. Robert Robertson of the Academy of Natural Sciences of Philadelphia, Pennsylvania, U.S.A.

Genus **TEREBELLUM** Lamarck, 1799

?Terebellum sp. indet. Pl. 28, fig. 13

Remarks. — An incomplete, poorly preserved specimen from Ewekoro is here referred doubtfully to *Terebellum.* The body whorl and part of the penultimate whorl preserved are vaguely suggestive of *Terebellum.*

Illustrated specimen. — UIMG No. 301.

Superfamily **NATICACEA** Gray, 1834

Family **NATICIDAE** Gray, 1834

Genus **EUSPIRA** Agassiz in J. Sowerby, 1838

Euspira togoensis (Furon) Pl. 21, figs. 1-6

Natica (Polinices) togoensis Furon, 1948, p. 102, pl. 8, fig. 16.
?Polinices togoensis Furon, Tessier, 1952, p. 379, pl. 33, figs. 4, 12, 15.

Description. — Shell small, with a short spire of about 3½-4 low whorls, and a gently convex outline. Body whorl elongate, somewhat compressed; umbilical perforation relatively wide and deep, with steep sides. Outerlip uniformly spherical, producing a wide, semilunar aperture which, in complete specimens, is straight along the inner lip margin. A narrow furrow separates the parietal face of the body whorl from the thin callosity along the upper margin of the inner lip.

Material. — Thirteen tiny specimens.

Types. — Hypotypes, UIMG Nos. 302-304, USNM Nos. 174823-174824.

Dimensions (mm). —

	height	maximum diameter
UIMG 302	19.25	15.70
UIMG 303	9.25	7.75
UIMG 304	6.15	4.95
USNM 174823	3.55	2.80
USNM 174824	4.85	4.35

Remarks. — This species was briefly described and inadequately illustrated by Furon (1948). It is represented in my collection by 13 tiny specimens including several immature forms. The apertural views of these specimens compare favourably with Furon's illustrated type.

Tessier's (1952) Senegal specimens are bigger and relatively higher than the Nigerian material. The low spire and compressed test suggest that they are conspecific.

Euspira togoensis is higher than *Natica osculum* Oppenheim and is less inflated than *N. servorum* Oppenheim (1904) both from the Eocene of the Cameroons.

Genus **SINUM** Bolten in Röding, 1798

Sinus akinkugbei Adegoke, new species Pl. 21, figs 7, 9-11

Description. — Shell small, naticoid, thick-walled. Spire short, consists of about 2½ tightly coiled whorls. Protoconch bulbous and smooth; last spire whorl relatively high with gently rounded side. Suture broadly channelled.

Body whorl widens abruptly and flares out abaperturally, producing a broadly convex outer lip. Umbilicus small, mostly filled with callus; aperture oblong-rounded. Body whorl and part of penultimate whorl ornamented by several subequal, flat-topped spiral ribs with interspaces as broad as the ribs; about 32 spiral ribs present on adult body whorl and base; interspaces cross-hatched by growth lines.

Material. — Two specimens.

Types. — Holotype, UIMG No. 305; paratype, USNM No. 174825.

Dimensions (mm). —

	height	maximum diameter
UIMG 305	4.75	4.25
USNM 174825	3.70	2.80

Remarks. — The diagnostic features of this species are its small size, the 32 ± spiral ribs, and the reticulation produced in the interspaces by the intersecting growth lines.

The new species differs from the Senegal species identified as *Sinum* sp. ind. aff. *clathratum* Gmelin by Tessier (1952, p. 379, pl. 33, fig. 3) by its shorter body whorl with a gentler posterior slope and the broadly channelled suture. The spiral sculpture of the latter is unknown. It is also more robust and more compact, with thicker shell and fewer broader spirals than the Paris Basin *S. clathratum* Gmelin (Cossmann and Pissarro, 1910-1913, pl. 10, fig. 62-1).

Sinum dusenberryi Caster (1938) from the Quimbriz Formation of Angola is much bigger, has a more inflated body whorl, a lower spire, and more numerous spiral threads than the present species.

The new species differs from *Sinum africanum* Newton (1922) from the Ameki Formation (Eocene) of eastern Nigeria by its smaller spire, the more inflated body whorl, and the more compressed apical axis. *Sinum nigeriense* Eames (1957) from the same locality has a more highly inflated body whorl and more numerous (about 40) spiral threads.

Named in honour of Mr. Olu Akinkugbe.

Family **AMPULLOSPIRIDAE** Cox, 1930

Genus **CROMMIUM** Cossmann, 1888

Crommium nigeriense Adegoke, new species Pl. 21, figs. 8, 12-15

Crommium sp.—Adegoke, 1972b, pl. 2, fig. 6.

Description. — Shell medium-sized, thin-walled, conical, with prominently elevated spire of 5-6 whorls. Spire whorls gently convex adapically, suture linear, narrowly incised. Body whorl large, inflated. Shell smooth but for growth lines. Inner lip margin broadly undulating, aperture hemispherical. Umbilicus narrow in young specimens (Pl. 21, fig. 13), completely closed by callus in adults. Parietal callosity thin.

Material. — Fourteen well-preserved specimens.

Types. — Holotype, UIMG No. 306; paratypes, UIMG No. 307, USNM Nos. 174826, 174827.

Dimensions (mm). —

	height	maximum diameter
UIMG 306	28.45	19.30
UIMG 307	12.15	8.30
USNM 174826	20.65	13.10
USNM 174827	11.10	6.15

Remarks. — This species differs from *Crommium (Amauropsella) lineolata* Furon, 1948 by its larger adult size, the more globose body whorl, and the absence of the spiral carination which occurs around the edge of the spiral suture of the Togolese species.

The adapical shoulder of the whorls of the new species is less prominent, the spire narrower, and the spiral suture less depressed than in *Ampullospira (Euspirocrommium) kouriatchyi* Furon (1948; also Tessier, 1952, p. 378, pl. 32, fig. 10). *Ampullospira (Euspirocrommium)* sp. indet. of Tessier (1952) from the quarry near Fallock (Paleocene) has a narrower, more acute spire, and a wider body whorl than the new species.

From published records, the genus *Crommium* as recognized here seems to characterize the Paleocene horizon in West Africa.

Subfamily **GLOBULARIINAE** Wenz, 1941

(Ampullininae)

Genus **GLOBULARIA** Swainson, 1840

Globularia guineensis Adegoke, new species Pl. 21, figs. 16-19

Description. — Shell small to moderately large, spire high, consisting of about seven-eight smooth, convex whorls. Earliest spire whorls increase uniformly in diameter as added, later whorls increase abruptly producing an obtuse spire crowned by an initial narrow, conical cap. (Pl. 21, figs. 17, 18). Body whorl large, globular, increases in diameter abruptly compared with penultimate whorl, and constitutes more than ⅔ height of shell, angulated near the adapical margin. No sculpture was observed. Base not well preserved, an umbilicus may have been present.

Material. — The new species is based on four specimens.

Types. — Holotype, UIMG No. 308; paratypes, UIMG No. 309, USNM No. 174828.

Dimensions (mm). —

	height	maximum diameter
UIMG 308	5.55	5.05
UIMG 309	18.30	15.35
USNM 174828	4.15	4.35

Remarks. — This new species is represented in my collection by four specimens all lacking completely preserved body whorls. The degree of inflation of the preserved remnant seems to justify the generic assignment of the species.

The new species is characterized by its high, robust spire in which earlier whorls are narrower than later whorls. It is the first *Globularia* recorded from the Tertiary of West Africa.

Genus **AMPULLINA** Bowdich, 1822

Ampullina tapina Vincent **kogbei** Adegoke, new subspecies
Pl. 21, figs. 20-25

?*Ampullina* sp. Furon, 1948, p. 103.
Ampullina tapina Vincent, n. subsp., Adegoke, 1972a, pl. 3, figs. 4, 19.

Description. — Shell small to medium-sized, moderately thick, globose; spire relatively low, consisting of about seven whorls which increase in steps as added; diameter of each spire whorl about three times its height, wall straight-sided, gently rounded at shoulder. Body whorl large, slightly wider than high, with well-developed shoulder near adapical margin, gently rounded anteriorly. Final whorl of immature specimens ornamented by about 6-10 faint spiral threads (Pl. 21, figs. 22, 24, 25).

Suture distinct, channelled. Aperture oblong, semilunar, narrow adapically, broadly curved anteriorly. Parietal area covered by thin callus. Umbilicus narrow, hemispherical, partially covered by callus.

Material. — Fourteen specimens representing all growth stages.

Types. — Holotype, UIMG No. 143; paratypes, UIMG Nos. 142, 310, USNM Nos. 174829, 174830, PRI No. 29824.

Dimensions (mm). —

	height	maximum diameter
UIMG 142	7.10	5.55
UIMG 143	23.10	17.80
UIMG 310	17.20	13.40
USNM 174829	24.25	19.75
USNM 174830	12.80	9.40

Remarks. — The diagnostic features of the new subspecies are the small, narrow spire, with low, shouldered whorls; the narrow, hemispherical umbilicus, the thin callus and the presence on young body whorls of the faint spiral sculpture.

The new subspecies differs from *Ampullospira kouriatchyi* Furon and *Crommium lineolata* Furon by the shorter, narrower spire. It is smaller and more rounded than *Ampullina* sp. of Tessier (1952, p. 378, pl. 32, figs. 1, 2) and it is slightly larger, with more rounded body whorl and narrower spire than *A. submarocana* Tessier (1952, p. 377, pl. 32, figs. 29, 30).

From *Natica juliae* (= *Amauropsella julei* Briart and Cornet) from the Calcaire Grossier de Mons, the new subspecies differs by its broader columellar lip, the narrower umbilicus and the more globose body whorl. The features of the unillustrated specimen described as *Ampullina* sp. by Furon (1948, p. 103) are identical with those of the new subspecies and suggest that they may be conspecific. The new subspecies is also morphologically close to *Ampullina tapina* Vincent (1913, p. 11, pl. 1, fig. 3) from the Paleocene of Landana. Hence the former is here considered a subspecies of the latter.

The new subspecies is named in honor of Dr. C. A. Kogbe, Department of Geology, University of Ife, Nigeria.

Superfamily **CYPRAEACEA** Rafinesque, 1815

Family **GISORTIIDAE** Jousseaume, 1884

Genus **GISORTIA** Jousseaume, 1884

Gisortia brevis Douvillé **ewekoroensis** Adegoke, new subspecies
Pl. 21, figs. 26-28

Gisortia, n. sp. Adegoke, 1972a, pl. 3, fig. 12.
Gisortia brevis Douvillé, Adegoke, 1972b, pl. 2, fig. 2; 1973, fig. 2.

Description. — Shell medium-sized, globose. Spire low, consisting of about three-four whorls which are not raised above shell surface. Body whorl large, constituting the bulk of the entire shell, ovoidal, with broadly rounded adapical shoulders. Shell thin-walled, probably smooth. Aperture moderately narrow, hemispherical, with sinuous inner lip margin, apical margin of outer lip not elevated above spire. Parietal surface wedge-shaped, being broad adapically tapering to a narrow anterior siphonal fasciole.

Material. — The new subspecies is based on the holotype only.

Type. — Holotype, UIMG No. 152.

Dimensions. — Height 45.30 mm; maximum diameter 40.75 mm.

Remarks. — This new subspecies is represented by only one internal cast. Its features are sufficiently distinct from those recorded from equivalent strata in other areas (Vredenburg, 1927; Schilder, 1930; Ingram, 1940) to merit subspecific designation.

The new subspecies resembles *Gisortia murchisoni* d'Archiac recorded by Cossmann and Pissarro (1909) from Zone 2 of the Upper Ranikot Series, India, but differs in having a smaller size, an unelevated posterior edge of the outer lip and the absence of spiral sculpture.

The smoothness of the new subspecies distinguishes it from *G. tuberculosa* Duclos. *G. jacqueti* Tessier (1952) is larger, more angulated at the shoulder, and with wider spire whorls.

The new subspecies may be distinguished from *Gisortia clarki* Ingram (1940, 1948) from the Eocene of California, by its smaller size, the less robust and more gently rounded body whorl, and the non-elevated posterior margin of the outer lip. *Gisortia harrisi* Palmer (1957) is larger with more angulated apical and adapical shoulder, and outer lip margin elevated above spire.

The new subspecies most closely resembles *Gisortia brevis* Douvillé, recorded from various localities in the Iullemmeden Basin (Soudan, Niger, and northwestern Nigeria) (Douvillé, 1920; Furon, 1935, p. 78, pl. 7, figs. 8a, b; Parker, 1964, p. 28, pl. 9, fig. 1) and from the Lutetian of Senegal (Tessier, 1952). It differs by its fewer, less depressed spire whorls, and its more broadly flared outer lip whose adapical edge is not elevated above the spire. Both are considered closely related and the new form is regarded as a predecessor and a subspecies of *G. brevis* Douvillé.

Family **CYPRAEIDAE** Rafinesque, 1815

Genus **EOCYPRAEA** Cossmann, 1903

Eocypraea nigeriensis Adegoke, new species Pl. 22, figs. 1-4

Eocypraea, n. sp. Adegoke, 1972a, pl. 3, fig. 10; 1973, pl. 1, fig. 2.
Eocypraea sp. Adegoke, 1972b, pl. 1, fig. 3.

Description. — Shell large, hemispherical, smooth and gently rounded on the abapertural surface. Apertural surface flattened with moderately wide and sinuous apertural opening with point of maximum curvature in the adapical half of shell. Apertural diameter subequal in the adapical two-thirds of shell, widens out abruptly and becomes constricted near the anterior end. Outer lip margin thick, folded, more or less flattened near the anterior margin, bearing on the inner margin of the anterior portion several transverse ridges. Inner lip margin smooth with steeply inclined wall. Spire completely concealed.

Material. — Six more or less complete specimens.

Types. — Holotype, UIMG No. 150; paratype, UIMG No. 311, USNM No. 174831.

Dimensions (mm). —

	height	maximum diameter
UIMG 150	53.95	47.70
UIMG 311 (incomplete)	47.25	45.40
USNM 174831	66.05	57.85

Remarks. — The new species is well represented at Ewekoro. It differs from *Sphaerocypraea sudanensis* (Schilder) recorded from the Eocene of southern Nigeria (Newton, 1912; Eames, 1957) by its less sinuous and narrower apertural opening, the heavier outer lip and the less conspicuous ridges on the outer lip margin. *Bernayia expansa* d'Archaic and Haime and *B. globus* Douvillé from Sind, India, (Douvillé, 1929) have a more conspicuously elevated spire, a shorter and more globular body whorl, and a more sinuous aperture than *E. nigeriensis*. *Cypraea (Bernayia) saltoensis* Clark (1946) from Bolivar, Colombia, has an identical apertural opening but with more prominently denticulated lip margins.

The new species may be distinguished from *Eocypraea bartlettiana* Maury (Maury, 1912, p. 86, pl. 19, figs. 11-13; Schilder, 1939, p. 12; Ingram, 1942) by its much larger adult size, the less prominently elevated adapical margin of the outer lip, and the smooth inner lip margin. It closely resembles *Cypraea (Umbilia) furoni* Tessier (1952, p. 382, pl. 35, figs. 1-3, 7) in size, and convexity of final whorl but differs in possessing labral denticulations, a uniformly flattened columella and outer lip and a wider apertural opening.

Genus **CYPRAEA** Linnaeus, 1767

Cypraea ewekoroensis Adegoke, new species Pl. 22, figs. 5-9

Cypraea, n. sp. Adegoke, 1972a, pl. 3, fig. 16; Adegoke, 1973, pl. 1, fig. 14.
Cypraea sp. Adegoke, 1972b, pl. 1, fig. 11.

Description. — Shell moderate to large, hemispherical, with broadly convex abapertural surface and gently flattened apertural surface. Spire concealed. Parietal surface of inner lip swollen adapically, tapers rapidly and merges with narrow, slightly twisted columella which encloses a shallow fossula. Outer lip rim swollen, adapical edge raised higher than parietal margin. Inner and outer lip margins bear a row of fine denticles of which the anterior ones are the most prominent. Apertural opening of subequal diameter adapically, broadly sinuous; opening out into a narrow atrium anteriorly. Shell completely smooth.

Material. — The new species is based on 14 specimens.

Types. — Holotype, UIMG No. 312; paratypes, UIMG Nos. 155, 313, USNM Nos. 174832, 174833.

Dimensions (mm). —

	height	maximum diameter
UIMG 155	22.05	15.80
UIMG 312	27.50	21.55
UIMG 313	26.65	18.75
USNM 174832	27.50	20.25
USNM 174833	21.85	15.50

Remarks. — This species is characterized by its numerous, fine labral denticulations, and the smooth shell. It differs from *Cypraea sublandanensis* Oppenheim (1915) from Togo by its larger size, the broader, more abruptly truncated shell, and the less prominent labral denticulations. *C. landanensis* Vincent (1913) differs from the new species by its more globose shell which lacks denticulations on both the inner and outer lips.

From *Eocypraea* sp. (Tessier, 1952, p. 381, pl. 32, figs. 25, 26) and *Eocypraea bartlettiana* Maury *elongata* Tessier (1952, p. 381, pl. 33, figs. 9, 11, 13) from Senegal, the new species may be distinguished by its broader, less elongate shell, the presence of labral denticulations, and the broader siphonal canal. *Eocypraea mokattamensis* (Oppenheim, 1906, p. 33, pl. 24, fig. 22; pl. 25, fig. 17) is more elongate and more slender with narrower aperture and more prominent but fewer denticulations than the new species.

The new species is stouter, shorter, and more globular than *Ovula negritensis* Olsson (1928, p. 74, pl. 20, fig. 3) from Peru and *Transovula nincki* Cossmann (Cossmann and Pissarro, 1905; 1904-1906, pl. 65, fig. 160-4) from the Paris Basin. It is also stouter and wider than *Eovolva nigeriensis* (Newton) from the Eocene of eastern Nigeria. The latter is also reticulately sculptured, with a narrower apertural opening.

Genus **CYPRAEDIA** Swainson, 1840

Cypraedia ogbei Adegoke, new species — Pl. 22, figs. 10-13

Description. — Shell small, hemispherical, uniformly rounded, and with subrectangular outline. Apical whorls few, tightly folded, concealed. Parietal portion of body whorl moderately wide, tapers rapidly to form the gently curved columella. Outer lip thin, margin expanded, producing a broad aperture. Shell thin, smooth, faintly crossed by growth striae. Siphon short and broad.

Material. — The new species is based on two specimens.

Types. — Holotype, UIMG No. 314; paratype, USNM No. 174834.

Dimensions (mm). —

	height	maximum diameter
UIMG 314	12.85	9.20
USNM 174834	8.50	5.55

Remarks. — This small species is represented in my collection by two specimens. It differs from *Cypraedia elegans* Defrance (also Oppenheim, 1906; Tessier, 1952) in being more uniformly rounded, the body whorl is shorter and tapers more rapidly anteriorly and the aperture is wider. It differs also from *Cypraedia fenestralis* Conrad (1854) by its wider anterior margin and the absence of sculpture.

Cypraedia (Cypraeoglobina) feddeni (Vredenburg, 1929) has a more robust parietal surface and a narrower anterior canal than the present species.

The new species is named in honor of Mr. F. G. A. Ogbe.

Family **BUCCINIDAE** Latreille, 1825

Genus **SYCOSTOMA** Cox, 1931

General statement. — *Sycostoma*-like gastropods form an important component of the Ewekoro fauna. These specimens show considerable morphological variation especially with respect to height of spire, robustness of whorls, degree of flattening, twisting and excavation of columella, and the thickness of callus.

Eames (1957, p. 44) proposed the generic name *Pseudomazzalina* for a *Sycostoma*-like species, *P. nigeriensis* (Newton) from the Eocene of eastern Nigeria. He characterized the genus as thin-shelled, inflated-fusiform, entirely smooth, with thin callus and a gently excavated, slightly bent columella lacking columellar plication, and a siphonal fasciole. The genus, as thus defined, is closely similar to *Sycostoma* Cox, 1931b. According to Eames (*op. cit.*), the major differences are that *Sycostoma s. s.* is less fusiform and has heavier columellar callus; and its outer lip is less excavated adapically. To this may be added that all recorded species of *Sycostoma* tend to be shorter spired.

Though Eames' name leads one to assume that *Pseudomazzalina* is closely related to *Mazzalina,* the absence of columellar plication in the former is considered significant, so also is the *Sycostoma*-like growth line sinuses. As a result, *Pseudomazzalina* is considered closer related to *Sycostoma* and is thus here regarded as a subgenus of *Sycostoma*. Two of the specimens from Ewekoro are referrable to *Sycostoma (Pseudomazzalina)* (Pl. 22, figs. 14-19); one is high-spired and the other low-spired with an excavated columella.

The greater proportion of the collected specimens are highly inflated, smooth, short-spired, with moderately thick callosity. They also show a prominent flexure of the columella. These are here included in the subgenus *Sycostoma s. s.* (Pl. 23, figs. 1-10).

Finally, a few specimens, apart from their *Sycostoma*-like general features, bear an intricate sculpture consisting of wavy spiral sutures, faint spiral ribs, and doubly and deeply sinused growth lines. The new name *Parkeristoma* is proposed for these (Pl. 23, figs. 11-20).

Subgenus **PSEUDOMAZZALINA** Eames, 1957

Sycostoma (Pseudomazzalina) ewekoroensis Adegoke, new species
Pl. 22, figs. 14-16

Description. — Shell moderately large, thin, fusiform. Spire high, consisting of about six (apex broken) high, convex whorls. Body whorl high, almost four times height of spire, moderately inflated with maximum width about the middle of the whorl. Columella long, cylindrical, and straight, not excavated. Columella and parietal surface covered by thin callus. Shell smooth. Aperture elongate oval, tending to subquadrate, with a narrow adapical canal, merges anteriorly with the short, wide siphonal canal. Suture distinct, linear, narrowly grooved.

Material. — The new species is based on the holotype only.

Type. — Holotype, UIMG No. 315.

Dimension. — Height 31.20 mm; maximum diameter 16.86 mm; height of aperture and siphonal canal 21.30 mm.

Remarks. — The new species closely resembles *Sycostoma (Pseudomazzalina) nigeriensis* (Newton) but may be readily distinguished by its shorter spire, the slenderer shell, and the higher body whorl. From S. *(P.) eamesi* Adegoke, new species, it may be distinguished by its relatively higher spire, the more convex whorls and the non-excavated columella.

Sycostoma (Pseudomazzalina) eamesi Adegoke, new species
Pl. 22, figs. 17-19

Description. — Shell medium-sized, elongate, fusiform. Spire short, consisting of about five-six low but wide whorls; earliest spire whorls narrow and acute, later whorls wide, about three times as wide as high. Body whorl moderately inflated, elongate, decreasing in diameter gradually anteriorward. Shell smooth but for growth lines.

Columella stout, slightly twisted and bent, moderately excavated, with thin callosity. Aperture elongate-oval, merging insensibly with the narrow, siphonal canal. Growth lines distinct, with a broadly curved, shallow apical sinus, and a broadly curved anterior sinus (Pl. 22, fig. 18).

Material. — The new species is based on the holotype only.

Type. — Holotype, UIMG No. 316.

Dimensions. — Height 31.75 mm; maximum diameter 17.00 mm; height of aperture and siphonal canal 23.50 mm.

Remarks. — Though named for only a single specimen, the present species is sufficiently distinct from *S. (P.) ewekoroensis* Adegoke, new species, to merit specific recognition. It has a shorter spire made up of few, low whorls, the earliest of which form a slender conical cap on top of later whorls. Whorl width to height ratio is about 3 to 1. Besides, the columella is flattened, gently twisted, and excavated. The anterior canal is longer with the shallow, double sinuses of the growth lines converging on it.

The new species differs from *Sycostoma (Pseudomazzalina) nigeriensis* (Newton) by its shorter spire, the low whorls, and the excavated columella.

Subgenus **SYCOSTOMA** s.s.

Sycostoma (Sycostoma) jonesi Adegoke, new species Pl. 23, figs. 1-6

Description. — Shell medium-sized, with short, acute spire of about six whorls. Earliest four spire whorls narrow and moderately high, almost straight-sided and increasing only slightly in diameter as added. Last two spire whorls increase abruptly in diameter, low, with gently sloping wall, slightly angulated below the middle. Suture linear, slightly incised.

Body whorl moderately large, constituting about 4/5 height of shell. Columella short, stout, only slightly curved anteriorly, slightly excavated, and covered by a thin callosity. Outer lip thin, convex with well-developed posterior anal canal. Siphonal canal short and wide. Growth lines distinct (Pl. 23, fig. 6), gently sinuous.

Material. — Twelve well-preserved specimens.

Types. — Holotype, UIMG No. 317, paratypes, UIMG Nos. 318, 319, USNM Nos. 174835, 174836, PRI Nos. 29795-29796.

Dimensions (mm). —

	height	maximum diameter
UIMG 317	28.45	17.15
UIMG 318	27.00	17.80
UIMG 319	24.25	14.45
USNM 174835	21.10	13.40
USNM 174836	18.65	11.45

Remarks. — The diagnostic features of this species are its small spire and the smooth, broadly convex, featureless body. It resembles small specimens of *Sycostoma subpirus* Moret (Salvan, 1954, p. 193, pl. 15, figs. 1-7) from the Lutetian of Tunisia, Algeria, and Maroc, but may be readily distinguished from it by its much smaller adult size, the linear suture, the less excavated columella, wider posterior anal canal, and the absence of pronounced angulation of the body whorl. It differs from *Sycostoma pyrus* (Solander) by the small spire, the gentler rounded body whorl lacking angulation, and the absence of spiral sculpture.

The new species resembles *S. priscum* Vincent (1930, p. 49, pl. 2, fig. 13) from the Montian beds of Poudingue differing only by its shorter spire, the more robust body whorl, and the straighter, shorter columella.

Sycostoma (Sycostoma) robusta Adegoke, new species Pl. 23, figs. 7-10

Description. — Shell small to large-sized, consisting of a moderately elevated spire of 4-4½ low, gently convex whorls which increase fairly rapidly and uniformly in diameter as added. Spire whorls smooth. Body whorl large, smooth, inflated medially and relatively short, angulated near the adapical margin, and truncated anteriorly producing a robust, medianly inflated, sub-quadrangular body whorl. Columella short, stout cylindrical, strongly recurved anteriorly. A thin callus covers columella and parietal surface. Aperture wide and semicircular in immature specimens, smaller, narrower, and oval in adult. Suture distinct, linear.

Material. — Three immature and one nearly complete adult specimens.

Types. — Holotype, UIMG No. 320; paratypes, USNM No. 174837, UIMG No. 321.

Dimensions (mm). —

	height	maximum diameter
UIMG 320	31.75	28.30+
UIMG 321	4.05	2.75
USNM 174837	5.00	3.90

Remarks. — This species is represented by three immature and one adult specimens in my collection. It is characterized by its moderately low spire in which whorls increase progressively in diameter, the short, robust, subquadrangular body whorl and the stout, strongly recurved columella. The species may be readily distinguished from *Sycostoma (Sycostoma) jonesi* Adegoke, new species, by its more robust shell, the shorter, stouter, and strongly curved columella. The height to diameter ratio in the new species is approximately 1 where it is slightly less than 2 in *S. (S.) jonesi* Adegoke, new species.

The new species is named in honor of Dr. H. A. Jones, formerly of the Geological Survey of Nigeria.

Genus **PARKERISTOMA** Adegoke, new genus

Diagnosis. — Medium to large-sized *Sycostoma*-like shells. Spire moderately high consisting of six to seven low wide whorls. Spire sculptured by flat to moderately raised axial nodes which are most prominent near the adapical margin and suppressed in the middle and only gently raised near the adapical margin. Suture markedly wavy, the concave portions coinciding with the positions of spines while intervening crests are excavated.

Body whorl large, expanded, and sharply angulated near the middle, ornamented by faint to moderately developed spirals.

Growth line conspicuous, doubly-sinused with a broadly curved, moderately deep antispiral sinus, with maximum curvature about the equatorial crest of the body whorl and a broader, shallower anterior sinus. Columella straight, stout with moderately thick callus. Aperture narrow, elongate-oval with well-developed posterior anal canal. Siphonal canal narrow and moderately long.

Type species. — *Parkeristoma guineensis* Adegoke, new species.

Remarks. — This new genus superficially resembles *Sycostoma* Cox, 1931b. The type species of the latter from several localities in France as well as American species referred to the genus were examined by the writer. The new genus differs from these by the sinuous suture and the peri-sutural nodes developed on the spire. The body whorl is more inflated, angulated along the equator on adult whorls. In the type species, a prominent "keel" is developed around the equator of the body whorl. More important, the posterior sinus of the growth line of *Parkeristoma* is deep and uniformly curved whereas this sinus is shallow in *Sycostoma.*

The new genus is named in honor of Dr. D. H. Parker formerly of the Geological Survey of Nigeria.

Parkeristoma guineensis Adegoke, new species Pl. 23, figs. 11-15

Description. — Shell large, thick-walled. Spire moderately high, consists of about six-seven whorls, the last two of which increase more rapidly in diameter than others. Suture narrowly incised, with wavy outline. Adapical margin of spire raised to form broad nodes separated by narrow grooves. Nodes alternate with grooves along adjacent whorls.

Body whorl large, inflated, maximum diameter occurs along the angulated equator, angulation accentuated by development on adult body whorl of a keel-like spiral band. Body whorl sculptured by other faint spiral threads. Growth line distinct, consists of a deep, broadly curved antispiral sinus with point of maximum curvature just above the equator, and a shallow spiral sinus. Columella stout and cylindrical, only slightly bent anteriorly. Outer lip inflated; aperture relatively narrow, elongate-oval. Siphonal canal moderately long, narrow. Thin callus covers columella and parietal surface.

Material. — Three well-preserved specimens.

Types. — Holotype, UIMG No. 322; paratypes, UIMG No. 323, USNM No. 174838.

Dimensions (mm). —

	height	maximum diameter
UIMG 322	69.62	40.00
UIMG 323	40.10	25.75
USNM 174838	54.90+	35.20

Remarks. — This new species is characterized by its large adult size, the not-too-distinct ridges on the spire whorls and the prominent equatorial angulation of the body whorl. It differs from *Parkeristoma reymenti* Adegoke, new species, by its relatively shorter and wider shell, the less conspicuous suture, and the less prominent spiral sculpture.

The holotype was collected by Dr. Barry Pass, formerly of the Physics Department, University of Ife.

Parkeristoma reymenti Adegoke, new species Pl. 23, figs. 16-20

Description. — Shell small, spire low, consisting of about six low, but wide whorls. Sutures sinuous, concavity occupied by axial sculpture which is subequally prominent near the adapical and abapical margin of spire whorls and depressed in the middle. Last suture less sinuous than others. Body whorl large, constituting about 4/5 height of shell, uniformly rounded, faintly sculptured by broad spiral ribs which are more prominent in the lower part of whorl (Pl. 23, fig. 17). Columella straight, stout, with heavy callus deposit whose outer contact with shell is marked by a linear depression. Outer lip margin ovate, with well-developed adapical channel and parietal ridge, opens anteriorly into the wide, parallel-sided siphonal canal. Growth line conspicuous, with subequally deep posterior and anterior sinuses forming an inverted S (Pl. 23, fig. 20).

Material. — Three well-preserved specimens only.

Types. — Holotype, UIMG No. 324; paratypes, UIMG No. 325, USNM No. 174839.

Dimensions (mm). —

	height	maximum diameter
UIMG 324	27.16	16.00
UIMG 325	21.86	13.57
USNM 174839	18.25	13.01

Remarks. — This species may be readily distinguished from *Parkeristoma guineensis* Adegoke, new species, by its smaller size, the more inflated, convex penultimate whorl, the narrower body whorl, the thicker callus deposit, and the more prominent and orderly development of spiral sculpture. Additionally, the apical tip of the dorsal sinus of the growth line is more sharply flexed near its junction with the suture.

The new species is named in honor of Professor R. A. Reyment.

Genus **TRITONIDEA** Swainson, 1840

Tritonidea africana Adegoke, new species Pl. 24, figs. 1-8

Description. — Shell minute, bucciniform, sturdy and moderately thick-walled. Spire moderately high, with a non-acute spire of about four-five lobulate whorls which are much wider than high. Protoconch and nuclear whorls also rounded and smooth. Spire whorls ornamented by few, prominently raised costae separated by slightly wider but shallow interspaces. Costae run entire length of whorl and are continuous but obliquely oriented from whorl to whorl. They are intersected by about six or seven prominent spiral ribs.

Body whorl high, constituting about ⅔ height of shell; ornamented by about six or seven or occasionally up to ten subequal costae, intersected by seven spiral ribs. Columella stout, dextrally flexed, with thin callus deposit. Aperture moderately wide, oval, opens anteriorly into the short, wide siphonal canal. Outer lip highly convex bearing 10 labral denticles. Suture distinct, incised on young whorls, channelled or deeply impressed on adult whorls. Faint growth striae sculpture entire shell.

Material. — Six specimens.

Types. — Holotype, UIMG No. 326; paratypes, UIMG Nos. 327, 328, USNM Nos. 174840-174842, PRI Nos. 29797, 29798.

Dimensions (mm). —

	height	maximum diameter
UIMG 326	3.25	2.25
UIMG 327	3.55+	2.35
UIMG 328	—	—
USNM 174840	4.10	2.05
USNM 174841	2.6	1.2
USNM 174842	2.0	1.0

Remarks. — This species is characterized by its minute size, the few broad axial costae, and the subequally prominent spiral ribs. It most closely resembles *Tritonidea rosenkrantzi* Ravn (1939, p. 76, pl. 3, figs. 11a-b) from the Paleocene of Copenhagen but differs by its smaller size, the more robust and rounded apical whorls, the fewer axial costae, and the fewer but more prominent spiral threads.

The new species is also closely comparable with *Tritonidea axesta* (Bayan) from the Lutetian of the Paris Basin (Cossmann and Pissarro, 1910-1913, pl. 37) but differs by its more prominent axial costae and the less excavated columella.

The specimens here assigned to the new species are superficially similar to *Janiopsis ewekoroensis* Adegoke, new species. They differ primarily in the straighter, smoother columella which are devoid of columellar sculpture. The apex is also less acute.

Genus **JANIOPSIS** Rovereto, 1899

Janiopsis ewekoroensis Adegoke, new species Pl. 24, figs. 9-11

Description. — Shell small, sturdy, and thick-walled. Spire high, consisting of about five highly ornate whorls. Protoconch and first two nuclear whorls rounded and smooth. Later whorls bear few prominently elevated axial ribs separated by wider flat-bottomed interspaces. Eight axial ribs adorn the final whorl, seven on the penultimate whorl. Costae are not continuous from whorl to whorl and are orientated obliquely. Suture incised, slightly wavy.

Body whorl large, comprising about half entire height of shell. Aperture narrowly elongate, opens anteriorly into a well-defined, parallel-sided and moderately long siphonal canal. Columella stout, deflexted dextrally adapically and slightly backward anteriorly.

Bears about three transverse nodes in its upper segment and the exterior surface is sculptured by several fine threads. Labrum smoothly curved, thick-walled, bears a submarginal varix, and is internally denticulate.

Material. — The new species is based on two specimens.

Type. — Holotype, UIMG No. 329; paratype, USNM No. 174843.

Dimensions (mm). —

	height	maximum diameter
UIMG 329	6.00	3.00
USNM 174843	5.20	2.70

Remarks. — This species closely resembles the type species as figured by Wenz (1938, p. 120). It differs by its less developed callosity, less excavated columella, and the less prominent labral denticles.

The new species is smaller than *Janiopsis nigeriensis* Newton from the Eocene of eastern Nigeria (Newton, 1922, p. 41, Eames, 1957, p. 44; Adegoke, 1969b, pl. 1, fig. 15). The axial costae are heavier and more widely separated and the spiral ornamentation are finer, consisting of subequal, equidistant spiral threads whereas the latter have alternating coarse and fine spirals. They seem, notwithstanding, to be closely related.

Genus **SIPHONALIA** A. Adams, 1863

Siphonalia guineensis Adegoke, new species Pl. 24, figs. 12, 13

Description. — Shell small, fusiform, apical whorls unknown. Body whorl angulate at top, bears about seven broad axial ribs which are prominently elevated only at the shoulder; and separated by broad interspaces which are as wide as the ribs. Body whorl adorned by a series of alternating coarse and fine spirals of which the three located on the shoulder are the most pronounced; between the heavy and fine spirals are another series of tertiary threads; about 17 coarse spirals occur on the body whorl. The aperture is tear-drop-shaped with greater diameter apically, narrowing down abruptly anteriorly as it enters into the short, narrow, deep and parallel-sided siphonal canal. The columella is stout and is flexed anteriorly; it bears a shallow pseudumbilicus. The outer lip is thick-walled, crenate within, bearing nine complete and one incomplete denticles. Growth line is gently and broadly curved.

Material. — The species is based on the holotype only.

Type. — Holotype, UIMG No. 330.

Dimensions (mm). — Height 14.5 mm; maximum diameter 11.2 mm.

Remarks. — A single incomplete specimen of this species was collected in this study. The species is important because it represents the first record of the genus from the West African Tertiary. The new species may readily be distinguished from the American Claibornian Siphonalias (Palmer, 1937) by the sharper angulation of the upper part of the body whorl, the pronounced development of the spiral sculpture and details of the labral sculpture.

It differs from *Siphonalia phosoidea* Hanna and Israelsky (1925) from the Tertiary of Peru in that the axial ribs are not prolonged far anteriorly and the spiral sculpture consists of alternating coarse and fine spirals.

The new species resembles *Siphonalia aestuarina* Vincent (1930a) from the Paleocene of Limbourg, in the prominent elevation of axial sculpture on the body whorl angulation. They differ in that the adapical ramp of the body whorl of the new species is less extensive and steeper, the spiral sculpture more coarse, the columella stouter and less prominently flexed at the tip and the siphonal canal narrower than in the Limbourg species.

Siphonalia (Kelletia) subspadicea Vredenburg (1921; Mukerjee, 1939, p. 61, pl. 3, figs. 15-16) has a less expanded body whorl, a more oval aperture, finer, and more numerous spirals, and a shorter siphonal canal.

The new species is named for the Gulf of Guinea.

Siphonalia bryani Adegoke, new species Pl. 24, figs. 14-16

Description. — Shell medium to large; protoconch and earliest apical whorls not preserved; last two spire whorls angulated at middle, adapical portion slopes more gradually than the abapical portion. Body whorl large, almost twice as wide as the penultimate whorl and probably at least two-thirds height of entire shell. Sharply angulated adapically, tapering rapidly below the nodose angulation to the columellar tip.

Sculpture consists of a large number of axial nodes which are well developed in the lower half of spire whorls but suppressed above the angulation. About 10 axial ribs are present on the penultimate whorl of holotype, and 12 on the body whorl. Numerous spiral threads intersect the axials producing a reticulate sculpture. Spirals are most prominent on and between the axial ridges, they are faint above the whorl angulation.

Columella stout and cylindrical, its inner margin covered by a thin callus. Aperture oval and wide. Interior of labrum and labral denticulations not exposed. Anterior canal unknown, probably short, wide and slightly recurved. Suture wavy around bases of nodes. Growth line broadly curved adapically, maximum curvature occurs around the nodes.

Material. — The new species is based on the type specimens only.

Types. — Holotype, UIMG No. 331; paratype, USNM No. 174844.

Dimensions (mm). —

	height	maximum diameter
UIMG 331	35.80	25.42
USNM 174844	24.60	22.70

Remarks. — This species is characterized by its relatively large size, the prominent elevation of the nodes at the angles, and the reticulate sculpture.

It differs from *Siphonalia guineensis* Adegoke, new species, by its larger size, the more numerous nodes which are separated by wider interspaces, the fainter, more distantly placed primary spirals between which are a greater number of fine secondary and tertiary threads, the greater slope of the base, and the deeper growth line sinus.

The new species is named in honor of Mr. J. L. Bryan, Commercial Director, West African Portland Cement Company, Limited, Lagos, Nigeria.

Siphonalia nigeriensis Adegoke, new species Pl. 24, figs. 17-21

Description. — Shell minute, consisting of only five or six whorls in all. Nuclear whorls made up of about 3½ convex, smooth whorls. Spire whorls also convex, ornamented by about 11 narrow axial ridges separated by much wider interspaces. Interspaces crossed by six narrow spiral threads of which the first adapically is the most prominent; it is located close to the suture, around which it forms a narrow sutural band.

Body whorl high, constituting more than ⅔ height of shell, bears 10 axial costae which are prominently elevated only on the adapical half of the whorl, and suppressed on the anterior half. Whorls faintly crossed by several, closely spaced spiral threads of which the most adapical is most prominent. They follow the wavy outline of the suture. Suture linear on early spire whorls, deeply incised on later whorls. Columella long, narrow, dextrally curved anteriorly. Labrum thin, uniformly convex, merges gradually anteriorly into the wide, moderately long siphonal canal.

Material. — The four type specimens only.

Types. — Holotype, UIMG No. 332; paratype, UIMG No. 333, USNM Nos. 174845, 174846.

Dimensions (mm). —

	height	maximum diameter
UIMG 332	3.60	2.00
UIMG 333	3.75	1.85
USNM 174845	3.55	1.80
USNM 174846	3.05	1.85

Remarks. — Apart from its minute size, some of the morphologic features of this species are intermediate between those of the two other new species, *S. guineensis* Adegoke and *S. bryani* Adegoke. It differs from both in lacking a prominent angulation of the whorls. The axial costae have a gently arched profile and are more extensive axially than those of *S. bryani* but less than on *S. guineensis*. The spiral threads are fainter and are inconspicuous where they cross the axial costae, unlike in the other two species. Finally, the columella of the new species is longer, more twisted and with the labrum, encloses a relatively wider siphonal canal than in the other two species.

The new species resembles *S. guineensis* Adegoke in that the adapical spiral is heavier than the other spirals and forms a wavy band around the suture.

Genus **STREPSIDURA** Swainson, 1840

General statement. — Early Tertiary species of the genera *Strepsidura* Swainson, *Peruficus* Olsson, and *Glyptostyla* Dall have been confused because of their strong external morphologic similarities (Woodring, 1964, p. 289; 1970, pp. 434-435).

Strepsidura was characterized in Swainson's (1840) original description by the twisted columella and the development of a strong columellar plication. The genus *Whitneya* Gabb (1864) is a synonym (Stewart, 1926, p. 404).

Peruficus Olsson (1929, p. 25) has a straight anterior canal with two or three columellar folds, and *Glyptostyla* Dall (1892) is characterized by possession of one major wide fold anteriorly separated by a gap from four or five minor posterior folds. Additionally, the folds and furrows are located on a callous pad.

Sculpturing is highly variable among the genera as well as within each genus. *S. turgida,* the type species of *Strepsidura* from the Eocene of England has axial sculpture. *S. indica* Cossmann and *S. kerstingi* Oppenheim from the Tertiary of India and West Africa (Togo and Nigeria), respectively, have reticulate sculpture consisting of equally developed axial and spiral ridges. A similar reticulate sculpture is found in *Glyptostyla* and *Peruficus.*

The species described by Newton (1922) as *Strepsidura spirata* from the Eocene of eastern Nigeria was utilized by Eames (1957) as type species of a new subgenus *Strepsiduropsis* Eames. As pointed out by Woodring (1970), this Nigerian species has several columellar folds raised on a pad (Davies, 1935, figs. 434a,b; 1971, fig. 800a,b) and should be more correctly assigned to *Glyptostyla.* The writer examined the material studied by Eames at the British Museum (Natural History) and agrees with Woodring's suggestion.

Apart from *Strepsidura kerstingi* Oppenheim, several *Strepsidura*-like specimens were collected by the writer from the Ewekoro Formation of western Nigeria. These specimens differed significantly from typical Strepsiduras by the possession of two plications separated by a deep, relatively wide, flat-bottomed groove. They are described here as *Eamesidura* Adegoke, new subgenus. In order not to obscure their genetic affinity, they are retained as a subgenus of *Strepsidura.*

Strepsidura kerstingi Oppenheim Pl. 24, figs. 22-26

Strepsidura kerstingi Oppenheim, 1915, p. 58, pl. 5, figs. 4a, b; Furon, 1948, p. 108, pl. 9, fig. 11.

Description. — Shell small to medium, with moderately developed spire consisting of about five-six whorls. Body whorl large, angulated at the shoulder. Spire and body whorls beautifully ornamented by a variable number of costae and spirals. About three or four spirals present on penultimate whorl. Costae number 19 on young body whorls ranging to over 36 on some adults, their thickness and number being largely controlled by the nature of growth (see below). Spiral ribs vary less markedly than the axial, numbering between 12-16 on most body whorls. The columella is stout, strongly deflected to the right, and bears a strong plication which marks the upper border of the siphonal canal.

Material. — Over 30 well-preserved specimens.

Types. — Hypotypes, UIMG Nos. 334-336, USNM Nos. 174847, 174848, PRI Nos. 29799, 29800.

Dimensions (mm). —

	height	maximum diameter
UIMG 334	20.15	14.65
UIMG 335	12.40	8.50
UIMG 336	15.40	9.35
USNM 174847	16.40	10.40
USNM 174848	21.60	14.20

Remarks. — This highly variable species occurs abundantly at Ewekoro. The specimens exhibit extreme variability in the number of vertical costae on the whorls. A few specimens had few (about 18) broad costae separated by broadly channelled interspaces slightly broader than the ribs (Pl. 24, figs. 23, 24). In specimens with more costae (average about 26), the costae are relatively narrower and are separated by variably wide interspaces.

In old age, abnormally narrow, closely packed costae are developed attaining numbers as high as 38. The greater prominence of the growth lines in such cases indicates that this may be a gerontic feature valueless in taxonomy.

This species closely resembles *Strepsidura indica* Cossmann and Pissarro (1909) from the upper Ranikot beds of India. Material from the type locality, Jhirak, India, in the collection of the U.S. National Museum was examined by the writer.

Both, *S. kerstingi* and *S. indica,* have strongly deflected columella and the ornamentation is virtually identical. The West African species is more angulated at the shoulder and has more numerous and closer spaced spiral and axial sculpture. Both probably belong to the same stock and are here considered closely related.

S. kerstingi differs also from *S. scobina* Cox (1930, p. 192) by its coarser and fewer axial and spiral sculpture, and the more strongly deflected columella.

Subgenus **EAMESIDURA** Adegoke, new subgenus

Diagnosis. — Shell medium-sized, with small conical spire of about five or six low, wide whorls which are conspicuously ornamented near the adapical border by low axial nodes. Nodes located in the sinuous deflections of the suture. Last two spire whorls bear a few weak spiral threads. Body whorl inflated and high, constituting more than ¾ height of shell, lacks prominent axial sculpture but bears about 11 or 12 broad spirals near the anterior end and five faint threads adapically.

Columella blunt, straight adapically, strongly deflected, and slightly excavated anteriorly with a siphonal fasciole and a narrow pseudumbilicus. Two narrow columellar folds separated by a wide, steep, and parallel-sided groove present at the flexure. The adapical fold is less prominent than the anterior fold. A moderately thick callosity present on the columella and parietal surface. Aperture elongate-oval with narrow postanal canal and a narrow, oblique siphonal canal. Growth lines prominent with a small adapical fold and a wide, broadly curved anterior sinus.

Type species. — *Strepsidura (Eamesidura) newtoni* Adegoke, new species.

Remarks. — The diagnostic features of this new subgenus are the restriction of axial ornamentation to the spire, the wavy sutures, the double plications and groove on the columella, and the spiral ornamentation of the lower body whorl. It differs further from *Strepsidura s.s.* by its narrower aperture, the heavier but less extensive callus, and the more sinuous growth line pattern.

The new subgenus is named in honor of Dr. F. E. Eames.

Strepsidura (Eamesidura) newtoni Adegoke, new species Pl. 25, figs. 1-6

Description. — Shell medium-sized, thin and short-spired. Earliest spire whorls ornamented by axial ribs which are prominently elevated only in the adapical portion of whorl, suppressed in the middle and only slightly raised near the adapical end. Penultimate spire whorl bears two spirals on the nodes and a faint thread posteriorly; last spire whorl bears three prominent spirals on the nodes and two threads posteriorly. Apical end of body whorl ornamented by five faint spirals, lower body whorl ornamented by 11-12 prominent broad spirals. Body whorl slightly angulated around a belt defined by the upper margin of the outer lip.

Columella stout, strongly twisted anteriorly, with two unequal plications, (anterior heavier than posterior) separated by a wide, moderately deep, parallel-sided groove; a siphonal fasciole and pseudumbilicus present. A moderately heavy callus covers columella. Aperture, narrow, elongate-oval, with well-developed posterior anal canal. Growth lines conspicuous, straight at apical end, gently and shallowly curved in the middle, sweeping back in a broad shallow curve anteriorly, truncated abruptly against the siphonal fasciole from where it makes a sharp turn toward the siphonal canal approximately perpendicular to the columella.

Material. — The new species is based on nine specimens.

Types. — Holotype, UIMG No. 337; paratypes, UIMG No. 338, USNM Nos. 174849, 174850, PRI No. 29801.

Dimensions (mm). —

	height	maximum diameter
UIMG 337	28.65	17.80
UIMG 338	29.75	17.70
USNM 174849	23.70	13.80
USNM 174850	26.25	14.60

Remarks. — This species differs from *Strepsidura kerstingi* Oppenheim by its larger size, the presence of two plications separated by a groove, and the absence of the reticulate sculpture so well developed on Oppenheim's species.

The new species is named in honor of R. B. Newton.

Subfamily **PSEUDOLIVINAE** Fischer, 1884

Genus **PSEUDOLIVA** Swainson, 1840

General statement. — There has been little accord on the need for recognizing subdivisions of *Pseudoliva* Swainson.

Conrad (1865) listed under the name *Buccinorbis* six American Eocene species from among which Cossmann (1901) designated *P. vetusta* Conrad as type species. Davies (1935, but not 1971) utilized *Buccinorbis* as a distinct genus, and Wenz (1938-44) used it as a subgenus. Most modern American workers, however, prefer to use *Pseudoliva* as a generic name in a broad sense (Palmer and Brann, 1966; Gardner, 1945) though stressing the need for a closer study and possible subdivision of the group. Palmer (1937) used *Buccinorbis* as a "section". Gardner (1945, p. 196) remarked that *P. vetusta* has been used more "commonly for a group rather than for a single species". She, like Palmer (1937) realized that the group was susceptible to further subdivision.

Cursory examination of specimens and illustrations of several European, West African, and North American species indicates that several subgenera can validly be delineated on the basis of spire height to width ratio, apical sculpture, sculpture of body whorl, apertural and columellar characteristics, as well as the orientation of the growth line sinuses.

Most American species have moderately low spires, are heavy-shelled, with heavy columellar callosity, spiral ribs on body whorl, a moderately deep sutural groove and the growth line sinuses are in the form of an inverted but flat S-shape. This is virtually opposite the orientation in *Pseudoliva s.s.* (Wenz, 1938, fig. 3605). They, thus, deserve separate, subgeneric designation. Conrad's name, *Buccinorbis* adequately covers these forms.

The European and African Tertiary Pseudolivas are more variable. They range from high-spired spirally ornamented forms such as specimens described as *Buccinorbis kitsoni* by Newton (1922, p. 37, pl. 3, figs. 16-19) from the Eocene of eastern Nigeria, through high-spired weakly or non-spirally ornamented forms such as *Pseudoliva funkeana* Adegoke, new species, and *P. adelekei* Adegoke, new species, of this report (Pl. 25, figs. 7-23). All these species seem to lack well-developed axial sculpture on early whorls, they have narrow, restricted but elevated callosities on the columella and the shells are uniformly rounded, lacking prominent angulation. They probably merit distinct subgeneric designation.

By far the commonest *Pseudoliva* at Ewekoro are the medium to large-sized, flattened to oblong forms with relatively long, slightly excavated columella, well-developed siphonal fascioles and the adults deposit extensive callosities which cover much of the parietal surface as well as the spire. All but the last of the spire whorls are extremely tiny, forming a small sharply pointed conical cap and they are beautifully sculptured by narrow axial ridges with wide interspaces. A spiral groove cuts off a narrow adapical ridge bounding the suture of the penultimate and last whorls, the growth lines are only slightly sinuous and the five prominent spiral ribs are separated from the anterior body whorl by a deep, rounded groove.

This group (Pl. 25, figs. 26-30; Pl. 26, figs. 1-3), though referrable to a new subgenus superficially resembles, and may be closely related to Conrad's *Buccinorbis*. They differ by their smaller spire the more constant and more prominent development of axial sculpture on the apical whorls, the development of the apical spiral groove and ridge and the absence of spiral sculpture on the main body whorl. Many of the European Eocene species probably belong to this subgenus.

Finally, a single specimen of a new species with a moderately high spire was collected (Pl. 25, figs. 24, 25). The shell is reticulately sculptured by heavy axial and spiral ribs. The columella is straight with a deep and wide pseudumbilicus and a prominent siphonal fasciole. The callus is restricted to the columellar lip. The growth line consists on the body whorl of a deep antispiral sinus above the aperture and is wavy in the anterior portion. Collection of additional specimens may warrant separate subgeneric designation for this species.

Pseudoliva funkeana funkeana Adegoke, new species Pl. 25, figs. 7-16

Description. — Shell small, spire moderately high, consisting of about three-four gently convex whorls which are slightly inclined to the axis of shell. Protoconch small, bulbous, and smooth. Body whorl large, gently convex, constituting about two-thirds height of shell. Growth lines conspicuously furrowed, producing wide, sinuous axial bands on the penultimate and final whorls. Basal spiral groove narrow and relatively deep, extending from the inner lip to the outer lip margin and producing, in well-preserved specimens, a noticeable indentation of the outer lip. Aperture elongate-oval, widest portion near the anterior third, opens insensibly into the wide siphonal canal. Columella flattened, bears a thin callus.

Material. — Over 20 well-preserved specimens.

Types. — Holotype, UIMG No. 339; paratypes, UIMG Nos. 340-343, USNM 174851, 174852.

Dimensions (mm). —

	height	maximum diameter
UIMG 339	4.40	2.35
UIMG 340	5.60	2.80
UIMG 341	4.75	2.80
UIMG 342	3.85	2.30
UIMG 343	3.70	2.15
USNM 174851	4.65	2.50
USNM 174852	4.15	2.30

Remarks. — *Pseudoliva funkeana funkeana* Adegoke, new species is characterized by its small, smooth shell and the broad axial sculpture produced by the growth lines.

It is smaller and less robust than the inadequately figured specimen recorded as *Pseudoliva* sp. by Furon (1948, p. 111, pl. 9, fig. 19) from Togo.

The species closely resembles some Paleogene species described and figured by Briart and Cornet (1871, pl. 3) from the Calcaire Grossier de Mons. Among these, it shows the greatest similarity in size, form, and ornamentation to *Pseudoliva dubia.* It may, however, be readily distinguished by the more slender shell, flatter columella, wider axial bands and the much narrower and deeper labral groove.

P. funkeana is more uniformly tapered, less quadrate lacking angular nodes than *P. minutissima* Salvan from the Montian of Bouabout (Meskala), Maroc. It is also smaller and with less prominent axial ridges than the Senegal species referred to *P. canaliculata* Briart and Cornet by Chabaglian (1959, p. 150, pl. 2, figs. 8, 9).

Specimens of this species collected clearly indicate how natural selection may lead to local extinction of a species. From an early age, the specimens were preyed upon by naticids and muricids (see Paleoecology). Out of 20 specimens examined, 18 (that is, 90 percent) had naticid drill holes. A few had more than one hole.

The new species is named in honor of my daughter, Funke Adegoke.

Pseudoliva funkeana ornata, Adegoke, new subspecies Pl. 25, figs. 17, 18

Description. — Shell small, with a moderately high spire of about three-four whorls. Spire whorls uniformly rounded, about three times as wide as high. Suture distinctly grooved. Body whorl large, constituting more than ¾ height of shell, highly convex, sculptured by distinct growth lines which are shallowly sinuous, a small sinus occurs near the adapical margin of the body whorl, below which the growth line describes a gentle curve which terminates in a sharp flexure in the indistinct basal spiral groove. Anterior portion ornamented by about six irregular, broad spirals which are distinctly crossed by the sinuous growth lines (Pl. 25, fig. 17).

Columella stout, non-excavated, intersected by the growth lines adapically (Pl. 25, fig. 18), smooth anteriorly, and covered by a thin callus. Outer lip moderately thick with a conspicuous bulge in the lower third.

Material. — The holotype only.

Type. — Holotype, UIMG No. 344.

Dimensions. — Height 7.41 mm; maximum diameter 3.80 mm.

Remarks. — This new subspecies is represented by one specimen. It is larger than *P. funkeana funkeana* Adegoke and has a narrower, non-excavated columella, a more sinuous growth striae, a less conspicuous basal spiral groove, a wider aperture, and an ornate anterior portion (Pl. 25, fig. 17) below the basal groove.

The anterior sculpture of the new subspecies resembles that of *P. guineensis* Adegoke, new species. It differs by its more compact, elongate shell, and the much higher spire lacking any sculpture.

Because of their close morphological similarity, the new subspecies is here considered a subspecies of *P. funkeana*.

Pseudoliva adelekei Adegoke, new species Pl. 25, figs. 19-23

Description. — Shell medium-sized, with a moderately high spire of about two-three whorls each about three times as wide as high. Body whorl large, convex, constituting about 4/5 height of shell, sloping gently from the suture and attaining its maximum diameter about one-third of the distance down the body whorl. Shell ornamented by conspicuous, sinuous growth lines which form an irregular band of short, curved, ridges on the adapical portion of the body whorl some distance below the suture (Pl. 25, figs. 19, 20). Ridges are suppressed on the rest of body whorl.

Labral groove narrow and shallow, submedian in position, path of growth line only slightly deflected below it. Aperture wide, oval, with maximum diameter about halfway. Columella stout, flattened, covered by thin callus. Siphonal canal short and deeply notched.

Material. — The new species is based on the two type specimens.

Types. — Holotype, UIMG No. 345; paratype, USNM No. 174853.

Dimension (mm). —

	height	maximum diameter
UIMG 345	18.56	12.30
USNM 174853	12.60	9.22

Remarks. — This species is characterized by its moderately developed spire, the weakly developed curved ridges on the shoulder of the body whorl, and the gentle deflection of the growth lines below the labral groove.

It differs from *P. guineensis* Adegoke, new species, by its smaller size, larger spire, the flattened, non-excavated columella, and the absence of spiral ribs in the anterior portion of the body whorl.

The new species is relatively wider, with a wider more hemispherical aperture than *P. funkeana funkeana* Adegoke and *P. funkeana ornata* Adegoke. It differs also by its axial costae and the growth lines.

The new species is named in honor of Mrs. Catherine Adeleke, Gulf Oil Nigeria Limited, Lagos.

Pseudoliva rogersi Adegoke, new species Pl. 25, figs. 24, 25

Description. — Shell medium-sized, consisting of a moderately elevated spire of about five whorls and a large, uniformly spherical body whorl. Spire whorls and upper body whorl prominently sculptured by axial ridges, about 11 axials present on penultimate whorl and about 13 present on the body whorl. Three spirals cross these ridges on the penultimate whorl and about 13 on the body whorl (nine above the exterior spiral groove and four below).

Columella narrow, straight, covered by a thin callus which is restricted to the columellar area and the upper margin of the aperture. A deep and wide semilunar pseudumbilicus present, bounded abaperturally by a double crested, crescentic siphonal fasciole. Aperture oval, adapical canal obscured by callus. Siphonal canal extremely short, strongly notched. Adapical edge of body whorl above angulation depressed to form a shallow anal sinus in which the growth lines are sharply curved. Growth line conspicuous on the rest of body whorl, thrown into small waves.

Material. — The holotype only.

Type. — Holotype, UIMG No. 346.

Dimensions. — Height 20.65 mm; maximum diameter 14.62 mm.

Remarks. — *Pseudoliva rogersi* Adegoke differs from other described species by its stout, moderately high spire, the axial and spiral sculpture, the oval aperture, and the pseudumbilicus.

It is named in honor of Professor Allen S. Rogers, formerly of the Department of Geology, University of Ife, Nigeria.

Subgenus **BUCCINORBIS** Conrad, 1865

Pseudoliva (Buccinorbis) guineensis Adegoke, new species
Pl. 25, figs. 26-29; Pl. 26, figs. 1-3

Description. — Shell medium to large, irregularly obovate, moderately thick-walled; spire short, consists of about five-six whorls which form an acutely pointed apex; sutures conspicuously impressed. Spire whorls beautifully sculptured by about 15 narrow vertical ridges and two or three spiral threads. The costae are absent on the last spire whorl and on the body whorl. A deep, narrow groove marks off the adapical portion of the last spire whorl from the rest of the spire and continues round the shoulder of the body whorl thus forming a broad spiral ridge on the shoulder.

The upper body whorl is smooth but for the growth lines, the anterior half bears five prominent spirals separated by deeply grooved interspaces; of these the adapical spiral is widest. Width of spirals decreases progressively anteriorly. Anterior tip of columella flattened, excavated along its longitudinal axis. Siphonal fasciole prominent; siphonal canal wide, gutter-shaped. A heavy deposit of callus present on columella and parietal surface.

Material. — Thirteen well-preserved specimens.

Types. — Holotype, UIMG No. 349; paratypes, UIMG Nos. 347, 348, USNM Nos. 174854, 174855, PRI Nos. 29802, 29803.

Dimensions (mm). —

	height	maximum diameter
UIMG 347	22.15	16.75
UIMG 348	13.45	9.80
UIMG 349	37.00	24.25
USNM 174854	21.85	14.25
USNM 174855	33.40	26.00

Remarks. — This species exhibits considerable morphological variation. The juvenile whorls are obovate and more or less uniformly spherical. Adult and gerontic shells assume varying oblong shapes, accentuated by the non-uniform, heavy deposition of callus on the shoulder. The height of the spire is also variable. On some adult shells, so much secondary calcite may be deposited on the penultimate whorl that the spire appears depressed (Pl. 26, fig. 3).

The new species may be distinguished from *Pseudoliva eschi* Oppenheim (1904) from the Eocene of the Cameroons by its angulated shoulder, the more prominent callus, its shorter spire, and the presence of the broad spiral on the penultimate and body whorl. It differs also from *P. coniformis* Oppenheim (1904) by its irregular ovoid shape and the body whorl sculpture. The new species is also larger, more ovoid, and lacks the vertical ornamentation of *P. schweinfurthi* Oppenheim (1904). The new species is more slender, and with a less prominent shoulder than *P. leutweini* Böhm (*in* Kaiser, 1926) from southwest Africa. Besides, the anterior end of the columella is more elongate and more slender.

P. (Buccinorbis) guineensis Adegoke, new species, resembles the various American Tertiary subspecies of *Pseudoliva vetusta* (Conrad), the type of the subgenus *Buccinorbis* Conrad (Harris, 1896; Palmer, 1937; Palmer and Brann, 1966). It has a shorter spire, lacks spiral ornamentation on the upper body whorl, and the pseudumbilicus is less depressed. *Pseudoliva ostrarupis* Harris from the Wilcox Group, lower Eocene (Palmer and Brann, 1966) has a more uniformly spherical shell, a higher spire, and a shorter columella.

P. parinasensis Woods (1922) from Peru is higher-spired with less conspicuous sutures.

The new species resembles *P. (B.) vientoensis* Clark (*in* Clark and Durham, 1946) from Bolivar, Colombia, especially in the prominent development of the first groove on the anterior of the body whorl and the heavy callus. It differs by its sculptureless posterior body whorl and the narrower columella and siphonal canal.

The new species resembles *Pseudoliva (Buccinoıbis) chavani* Tessier (1952) from the Paleocene at Marigot de Balling, Senegal, in having a small spire and the lower body whorl sculpture. It may, however, be readily distinguished by its more irregular shape, the heavier callosity, the more elongate and narrower columella and the more prominent siphonal fasciole.

Family **PYRENIDAE** Suter, 1913

Genus **TETRASTOMELLA** Sacco, 1890

Tetrastomella? ewekoroensis Adegoke, new species Pl. 26, figs. 4-7

Description. — Shell small, consisting of an acutely tapering spire and a robust final whorl. Spire high, consisting of about six-seven rounded whorls about twice as wide as high, separated by distinct, channelled sutures. Penultimate and body whorls much larger than rest of shell, together they constitute more than one-third height of shell. Body whorl inflated, much wider than penultimate whorl.

Body whorl in larger specimen bears two faint spirals on the adapical half. Spire whorls smooth. Aperture semilunar, with long axis almost perpendicular to shell. Columella short, covered by a callus which extends over parietal surface. On the holotype, the wall of the final chamber shows three distinct calcitic layers, the outer and inner layers have a light cream color and are subequal in thickness. The middle layer is thickest and has a yellowish color.

Material. — Two specimens.

Types. — Holotype, UIMG No. 350; paratype, USNM No. 174856.

Dimensions (mm). —

	height	maximum diameter
UIMG 350	6.65	3.35+
USNM 174856	3.85	2.35

Remarks. — This species is represented in my collection by two specimens. It is characterized by its elongate acute spire, the enlarged body whorl and the absence of spiral sculpture except on the adult body whorl.

It resembles *Tetrastomella*? *pseudohumilis* described by Eames (1952, p. 95, pl. 3, figs. 86a,b, 87) from the Eocene of Pakistan. It differs by its more acute spire, the shorter, smaller but more expanded body whorl.

Family **HELIGMOTOMIDAE**, new family

Diagnosis. — Shell medium to large, pyriform, with short spire of three-four whorls which are only slightly elevated above the flattened apical surface. Apical surface plano-concave to gently convex, with shallow sutural groove in which the growth line sinus is strongly curved. Body whorl large, with expanded outer lip margin and a wide aperture. Sculpture consists mostly of columellar plications, oblique parietal ridges, and spiral nodes or spines.

Remarks. — The genus *Heligmotoma* was proposed by Mayer-Eymar (1895) for large, more or less smooth shells with well-developed mamelon and spiral sinus (type species: *H. niloticum* Mayer-Eymar). He placed it as a subgenus of *Melongena*. Mayer-Eymar (*op. cit.*) recognized three "varieties" of *H. niloticum* one of which was later accorded distinct specific status by Oppenheim (1906).

Douvillé (1920) erected the genus *Heligmotenia* (type species: *Heligmotenia molli* Douvillé) for similar Soudan and Senegalese forms with three columellar plications and a spiral band below the body whorl shoulder, resembling in the latter character the variety *bicarinata* of *Heligmotoma nilotica* of Mayer-Eymar. It is not known if the latter has columellar plications.

The writer collected in this study, three species of *Heligmotoma.* The largest, *H. nigeriensis* is smoothly rounded and lacks columellar plications. It is referred to *Heligmotoma sensu stricto.* The two other species are smaller; they bear two oblique parietal ridges, a single, variably prominent columellar plication, and have shallower apical sulci than *Heligmotoma s.s.* They are both here referred to *Douvilletoma* Adegoke, new subgenus.

The suprageneric classification of *Heligmotoma* and related forms has been problematic. They were placed in family Fusidae by Oppenheim (1906), Volutidae by Douvillé (1920), Melongenidae(?) by Mayer-Eymar (1895), Xancidae or Turbinellidae by Davies (1935), Galeodidae by Wenz (1938-44), and Vasidae by Salvan (1954).

Considered as a whole, the three genera *Heligmotoma, Heligmotenia,* and *Douvilletoma* combine morphological characters (such as the pyriform shape, low, flat to gently convex spire, apical sinus, expanded outer lip margin and the non-spinose, smooth shell) rarely found in the typical representatives of the families to which they had earlier been assigned. They are here recognized as a distinct family Heligmotomidae within the superfamily.

Genus **HELIGMOTOMA** Mayer-Eymar, 1895

Subgenus **HELIGMOTOMA** s.s.

Heligmotoma (Heligmotoma) nigeriensis Adegoke, new species

Pl. 26, figs. 8-12

Description. — Shell large, pyriform, thickwalled. Spire consists of about two-three whorls which are only slightly elevated above the apical surface. Spire whorls have a flattened to gently convex upper outline and are separated from the rest of the body whorl by a spiral groove.

Body whorl large, enclosing rest of shell and expanding rapidly in diameter thereby producing an expanded labrum and a wide aperture. Shell ornamented by growth lines which describe a moderately deep sulcus in the apical spiral groove, crosses the rest of the apical surface diagonally and runs straight down the rest of the shell. Columella stout, straight; aperture wide, subtrigonal with a more or less straight apical margin, widening gradually anteriorly, attaining maximum diameter about half way down the whorl, thereafter narrowing gently and merging insensibly with the wide siphonal canal.

Material. — The new species is based on five mostly complete specimens.

Types. — Holotype, UIMG No. 351; paratypes, UIMG No. 352, USNM 174857.

Dimensions (mm). —

	height	maximum diameter
UIMG 351	68.56	58.60
UIMG 352	36.40+	42.40
USNM 174857	59.82	63.0+

Remarks. — The diagnostic features of this species are its large size, the pyriform, smooth shell, the wide aperture, and the absence of sculpture other than growth striae.

It may be readily distinguished from *Heligmotoma (Heligmotoma) niloticum* Mayer-Eymar by its less depressed apical sulcus, more stream-lined, less quadrate body whorl, the shorter spire, the less prominently carinated shoulder, and the more expanded labral margin.

H. (H.) libycum Oppenheim (1906) has a shorter, squatter body whorl, with a heavier shoulder.

The new species differs from the other new species described from the Ewekoro Formation by its larger adult size, the thicker shell, the absence of parietal and columellar ridges and its more elegant, uniformly rounded shell.

Subgenus **DOUVILLETOMA** Adegoke, new subgenus

Diagnosis. — Small to medium *Heligmotoma,* with low spire of about three-four whorls which are only slightly elevated above the flattened apical surface. Body whorl large, enclosing much of the spire from which it is separated by a shallow groove in which the growth striae describe shallow sinuses. Apical shoulder of body whorl bounded by variably developed carina which may or may not be noded. Parietal surface bears two unequal, moderate to heavy, oblique ridges. Body whorl conspicuously constricted below the parietal surface. Columella narrow to heavy, bears one oblique plication of variable prominence. Aperture wide, hemispherical.

Type species. — *Heligmotoma (Douvilletoma) oluwolei* Adegoke, new species.

Remarks. — The new subgenus differs from *Heligmotoma s.s.* by its flatter apical surface, the subquadrate compressed body whorl and the presence of two parietal ridges and a columellar plication. Additionally the apical spiral groove and the sulci formed within it by the growth lines are not so deep as in species of *Heligmotoma s.s.*

The new subgenus differs from *Heligmotenia* Douvillé (1920) by the presence of only one columellar plication as against three in the latter and its two parietal ridges. Besides, the adapical constricted band of the body whorl so prominent in Douvillé's taxon is not noticeable on the new subgenus.

Two new species are assigned to the new subgenus, *H. (D.) oluwolei* Adegoke, new species, the type species of the subgenus and *H. (D.) oppenheimi* Adegoke, new species, a taxon first recorded as an indeterminate species from Togo by Oppenheim (1915).

The new subgenus is named in honor of Dr. H. Douvillé.

Heligmotoma (Douvilletoma) oluwolei Adegoke, new species
Pl. 27, figs. 1-6

Description. — Shell small to medium-sized, thin-walled, subconical with a long, pointed anterior canal. Spire extremely short, consisting of about three-four whorls forming a conical bosslike structure about 2 mm high above the gently convex apical surface. Protoconch bulbous, smooth; spire whorls also smooth.

Body whorl expands rapidly and encloses earlier whorls; strongly angulated at the shoulder bearing a sharp keel-like ridge which bears about 20 short, blunt spines. Body whorl gently excavated below spine row. Two oblique ridges present on parietal surface of which the adapertural is more prominent. Columella narrow, elongate, bearing a single faint plication visible only on the interior surface. Siphonal canal long, narrow. Shell finely sculptured by the growth striae, these form shallow sinuses where they traverse the shallow apical spiral groove, they cross the body whorl angulation and are parallel on the body whorl to the outer lip trace.

Material. — Eight well-preserved specimens.

Types. — Holotype, UIMG No. 353; paratypes, UIMG Nos.

354, 355, USNM Nos. 174858, 174859, PRI No. 29804.

Dimensions (mm). —

	height	maximum diameter
UIMG 353	32.15	24.95
UIMG 354	24.25	18.55
UIMG 355	29.20	19.45
USNM 174858	31.05	18.80
USNM 174859	27.75	25.40

Remarks. — This elegant species differs from *Heligmotoma (Douvilletoma) oppenheimi* Adegoke, new species, (see below) by the thinner, more streamlined shell, the less distinct columellar plication, and the strong nodulation of the body whorl shoulder. From *H. rogeri* Salvan (1954) from the upper Lutetian of Louis-Gentil and Timhadit, Maroc, the new species differs by its shorter spire, the more streamlined but higher body whorl and the more prominent shoulder spines. The Maroc species also lacks the two parietal ridges.

H. libycum Oppenheim (1906) has a shorter and stouter body whorl with a more prominent ridge around the shoulder. *H. clavaeforme* Böhm (in *Kaiser,* 1926) has a more slender, higher-spired shell, lacking prominent nodes on the shoulder.

The new species is named in honor of my friend, Dr. Abiodun F. Oluwole, Department of Physics, University of Ife, Nigeria.

Heligmotoma (Douvilletoma) oppenheimi Adegoke, new species
Pl. 27, figs. 7-11

Heligmotoma? sp. Oppenheim, 1915, p. 55, pl. 4, fig. 10.

Description. — Shell medium to large, thick-walled, slightly higher than broad. Spire consists of about three-four closely coiled whorls. Apical surface gently concave to gently convex, sharply angulated at the shoulder, and bearing a shoulder ridge which lacks nodes or spines.

Body whorl expands rapidly, with an ungainly but variable final form, usually compressed, truncated anteriorly and separated from the columellar tip by a continuation of the heavy oblique parietal ridge the anterior tip of which runs almost perpendicular to the columellar axis (Pl. 27, fig. 8). Columella stout, cylindrical, bears an oblique plication below the parietal surface. Aperture wide, hemispherical. A thin callus deposit covers columella and parietal surface.

Material. — Eight nearly complete specimens.

Types. — Holotype, UIMG No. 356; paratypes, UIMG No. 357, USNM Nos. 174860, 174861.

Dimensions (mm). —

	height	maximum diameter
UIMG 356	33.15	34.05
UIMG 357	30.35	22.45
USNM 174860	22.45	21.85
USNM 174861	33.75	29.50

Remarks. — This species is characterized by its irregular subquadrate profile, the shallow apical spiral groove, and the smooth shoulder ridge. It was first recorded by Oppenheim (1915) from Togo. It differs from *H. (D.) oluwolei* Adegoke, new species, by its heavier, thicker shell, the broader but shorter shell lacking the crown of nodes, and the heavier columellar plication.

The new species is named in honor of the late P. Oppenheim.

Family **MELONGENIDAE** Gill, 1871

Subfamily **MELONGENINAE** Gill, 1871

Genus **CORNULINA** Conrad, 1853

Subgenus **AFROCORNULINA** Adegoke, new subgenus

Diagnosis. — Medium-sized, *Cornulina*-like shell, with short, acute spire, ornamented by short spines which are well developed near the adapical and abapical ends of whorls and suppressed in between. Body whorl long, ornamented by a crown of nodes located a considerable distance below suture. Spine bases prolonged as broad ridges on the body whorl. Columella heavy and cylindrical, sharply bent abaperturally below body whorl and its tip is twisted and recurved toward the outer lip. Siphonal fasciole well developed, canal narrow and crescentic. Columella and part of parietal surface covered by callus.

Sculpture consists of a series of narrow, wavy spiral ribs separated by wide interspaces. Ribs few and faint on adapical portion of body whorl above the row of nodes.

Type species. — *Cornulina (Afrocornulina) africana* Adegoke, new species.

Remarks. — Critical examination of the type material of the European and American species assigned to the genus *Cornulina* Conrad shows that Conrad's genus is characterized by a short heavy, fusiform shell with rounded columella which is flexed sharply anteriorly, an emarginate siphonal fasciole, a large body whorl bearing two rows of short thick spines, and a deep *Pseudoliva*-like groove on the base of the body whorl (Palmer, 1937, p. 337; Harris, 1899, p. 64; Gardner, 1945, p. 201; Barry and Le Blanc, 1942, p. 134; Cossmann and Pissarro, 1910-13, pl. 39).

The material from the Ewekoro Formation of Nigeria here described as *Afrocornulina* resembles certain species of *Cornulina* sufficiently closely to merit designation as a subgenus of *Cornulina*. They differ from the type species in being more slender, and shorter-spired, with only one row of axially elongated nodes on the body whorl, lacking the *Pseudoliva*-type basal groove, and in having a more twisted and doubly bent columella.

The closest affinity of the new subgenus is with species from the Paleocene(?) and lowermost Eocene of the United States Gulf Coastal Plain. Among these, it resembles most closely specimens described as *Cornulina armigera* Conrad by Harris (1899, p. 63) especially the specimen with one row of spines (pl. 8, fig. 8). The occurrence of one row of spines in young forms or of an incipient second row in adults was found commonly in specimens from the American older Tertiary horizons. It seems likely then that the genus evolved from a Paleocene *Afrocornulina*-like form with only one row of spines.

Cornulina (Afrocornulina) africana Adegoke, new species

Pl. 27, figs. 12-15

Description. — Shell medium-sized, low-spired. Spire consists of about seven or eight low whorls about three times as wide as high. Suture sinuous. Spire whorls sculptured by "axial" nodes which are prominently developed near the base of whorl, are less so near the apical end. Nodes not arranged in perfect rows from whorl to whorl.

Body whorl elongate, bears a row of spines located far below the suture. Base of spines prolonged as axial ridges on the body whorl. Ramp above the spines sculptured by five spiral threads. Fifteen widely spaced threads occur on the body whorl below the spines. Columella heavy, cylindrical; anterior tip twisted and bent towards outer lip, producing a markedly emarginate siphonal fasciole and a small pseudumbilicus which is separated from the narrow, twisted siphonal canal by a narrow, raised ridge. Columella covered by a moderately heavy callus. Aperture narrow, elongate-oval.

Material. — The new species is based on the two type specimens.

Types. — Holotype, UIMG No. 358; paratype, USNM No. 174862.

Dimensions (mm). —

	height	maximum diameter
UIMG 358	31.00	16.45
USNM 174862	24.36	14.55

Remarks. — This elegant species is characterized by its short spire, the elongate body whorl, the heavy columella which is twisted and doubly bent anteriorly, and the narrow, oval aperture.

Its closest affinity is with *Cornulina* species especially the form figured as *C. armigera* Conrad by Harris (1899, pl. 8, fig. 8).

Genus **PUGILINA** Schumacher, 1817

Pugilina akoi Adegoke, new species Pl. 27, figs. 16, 17

Description. — Shell medium-sized, roughly biconic. Spire short, consisting of about five low whorls which expand in diameter rapidly as added. Spire whorls ornamented by short axial nodes which are prominently elevated only in the lower half of the whorls. Nodes alternate in position from whorl to whorl. Spiral suture typically wavy with deepest curves around the base of the nodes.

Body whorl large and wide, constituting more than 4/5 height of shell, strongly angulated at the shoulder below which it is adorned by about eight prominently elevated and moderately elongated axial ridges which are crossed by five prominent spiral ribs. Spirals are elevated where they cross the axials and are suppressed in the interspaces. The adapical row is the most prominent and others decrease in prominence more or less uniformly anteriorly. Body whorl strongly constricted below aperture and is ornamented by faint coarse spirals.

Columella stout and cylindrical, straight posteriorly and flexed anteriorly; deeply excavated below flexure. A thin callus covers the columella and adjoining parietal surface. Aperture narrow, elongate-oval, sharply constricted anteriorly where it joins the narrow, parallel-sided anterior canal. Outer lip margin broken, thick-walled, apical border slopes at an angle of about 45°, making an obtuse angle at the body whorl angulation.

Material. — The new species is based on the holotype only.

Type. — Holotype, UIMG No. 359.

Dimensions. — Height 28.20 mm; maximum diameter 23.16 mm.

Remarks. — This species is represented in my collection by a single well-preserved specimen lacking the anterior tip of the columella. It is characterized by its unique sculpture of heavy, prominently elevated axial costae and the fewer coarse spirals which intersect them, the thickened labrum and the narrow siphonal canal. The latter feature suggests that the Nigerian species is probably not referrable to *Pugilina sensu stricto.*

Pugilina akoi differs from *P. oedicnema* (Olsson, 1928, p. 85, pl. 17, fig. 2) from Peru by its shorter spire, the greater slope of the upper body whorl the heavier, excavated columella, and the coarser, fewer spiral sculpture.

The sculpture is reminiscent of that of *Murex (Phyllonotus) wadai* Cox (1930, p. 189, pl. 20, fig. 3) from the Samana Range, India. It differs by its more biconic shell, shorter spire, less prominent anterior sculpture, and wider axial ribs.

The new species may be readily distinguished from *Streptosiphon klinghardti* Böhm and *S. piriformis* Böhm (1926, p. 70, pl. 34) by its more prominently raised axial ribs, fainter anterior spiral sculpture, narrower aperture, and the less elongate siphonal canal. *S. piriformis* Böhm shows columellar plications (pl. 34, fig. 2a) and probably does not belong to this genus.

The new species is named in honor of Mr. B. D. Ako, formerly of the Geological Survey of Nigeria, Kaduna.

Family **FASCIOLARIIDAE** Gray, 1853

Genus **CLAVILITHES** Swainson, 1840

Subgenus **RHOPALITHES** Grabau, 1904

Clavilithes (Rhopalithes) toyei Adegoke, new species Pl. 28, figs. 1-3
Clavilithes (Rhopalithes) sp. Adegoke, 1972b, pl. 1, fig. 5.

Description.—Shell medium-sized, much like typical *Clavilithes;* spire short, irregular and stunted, consisting of five or six low whorls which are much wider than high. Spire whorls ornamented by heavy axial ribs which are more prominently elevated in the lower part of the whorl and are almost completely suppressed in the upper third of the whorl; about eight axial ribs present on the last spire whorl. Spire whorls also bear two spiral ribs, located on the axially sculptured lower ⅔ of the spire whorls, they are more conspicuous on earlier whorls, fainter or completely lost on later spire whorls.

Body whorl large, elongate; constituting with the elongate columella almost ¾ of shell; sculptured by eight prominently elevated axial ribs whose upper edges form a prominent shoulder on the body whorl. They are gently curved and are suppressed below the lower body whorl angulation. Interspaces between the axial ribs narrower than ribs. Lower half of body whorl sculptured by three faint spirals. Outer lip margin thin, enclosing a narrow, small, subquadrate aperture; upper margin folded over, producing a well-developed adapical channel of the aperture. A thin callus deposit covers the edge of the inner lip and columella. Columella elongate, tapers gradually and bears two subprominent plications (Pl. 28, fig. 1) about which several obsolete threads can be seen. Suture sinuous, impressed. Siphonal canal long and narrow.

Material. — The new species is based on three specimens.

Types. — Holotype, UIMG No. 360; paratype, USNM No. 174863.

Dimensions (mm). —

	height	maximum diameter
UIMG 360	42.45	18.65
USNM 174863	38.15	21.30

Remarks. — This species is represented by two almost complete and an incomplete specimens in my collection. They resemble the Paris Basin and British Eocene species illustrated by Cossmann and Pissarro (1910-1913, pls. 40, 41), Grabau (1904), and Wrigley (1927) differing only in the accentuation of axial sculpture on all whorls and the suppression of spiral ornamentation. The association of both characters appears to be an important characteristic of this species and helps to distinguish it from most other reported species.

Grabau based the generic separation of *Rhopalithes* on the possession of two well-marked plications on the columella. This feature, present in the Nigerian shells is considered of subgeneric importance here (see discussion on *Volutilithes*).

This record lowers the known vertical range of the genus and subgenus to the Paleocene. It should be noted here that Grabau's suggestion that well-sculptured shells gave rise to smooth forms is probably not tenable because of the well-developed sculpture of these Paleocene forms.

The new species is named in honor of my friend Prof. S. Afolabi Toye, Department of Zoology, University of Ibadan, Nigeria.

Subgenus **COSMOLITHES** Grabau, 1904

Clavilithes (Cosmolithes) oluwasanmii Adegoke, new species

Pl. 28, figs. 4-12

Description. — Shell medium to large, biconical. Spire high, acute, consisting of about eight-nine moderately low whorls; apical angle about 39°. Spire whorls ornamented by seven axial nodes which are prominently elevated on the lower half of the whorls but suppressed on the upper part. Three sub-prominent spirals with faint threads in the interspaces adorn the noded portion of each whorl; several fine threads adorn the unnoded upper portion.

Body whorl high and slender; constitutes more than half height of shell. Bears eight axial nodes in adults, six on immature shells; nodes abruptly depressed near the adapical border of the whorl. Faint spirals which are more conspicuous anteriorly superimposed on the axial sculpture. Suture linear to deeply incised, wavy around the bases of the axial nodes. Columella elongate, tapering gradually anteriorly, slightly swollen near the beginning of the siphonal canal and bears internally a single plication (Pl. 28, fig. 4). A narrow band of moderately thick callus deposited on the columella. Aperture very narrow, elongate-oval, with a moderately developed posterior anal canal, and opening anteriorly into a narrow siphonal canal.

Material. — The species is abundantly represented by over 50 mostly complete specimens.

Types. — Holotype, UIMG No. 364; paratypes, UIMG Nos.

361-363, USNM Nos. 174864, 174865, PRI Nos. 29805, 29806.

Dimensions (mm). —

	height	maximum diameter
UIMG 361	22.40	10.00
UIMG 362	14.95	7.30
UIMG 363	—	19.00
UIMG 364	61.70	25.75
USNM 174864	54.10	20.80
USNM 174865	45.85	15.95

Remarks. — The characteristic features of this species are the prominent axial ridges which are strongly developed only on the adapical portion of each whorl the suppression of spiral sculpture and the development of a single strong plication on the columella (Grabau, 1904; Wrigley, 1927, p. 238). This columellar plication fails to reach the outer edge of the columella. It is thus, best seen by removing part of the adult outer lip (Pl. 28, fig. 4).

The species differs from the Paris Basin and English Eocene species of *Cosmolithes* by its slenderer but more quadrate body whorl and the fainter spiral sculpture (Grabau, 1904; Cossmann and Pissarro, 1905, pl. 23; 1910-1913, pl. 41; Wrigley, 1927).

This species is one of the most abundant gastropods at Ewekoro. It is represented in my collection by over 50 specimens. The tips of the apex and columella are rarely completely preserved. One specimen (UIMG No. 363, Pl. 28, fig. 6) was interesting in that the shell was bent during preservation.

The new species is named in honor of Professor H. A. Oluwasanmi, Vice-Chancellor, University of Ife, Nigeria, in acknowledgement of his interest in geology.

Genus **LEVIFUSUS** Conrad, 1865

Levifusus sp. cf. **L. palaeocenicus** (Furon) Pl. 28, figs. 16, 17

Fusus (Levifusus ?) palaeocenicus Furon, 1948, p. 108, pl. 9, fig. 13.

Description. — Shell small, turriform, consisting of a moderately high spire of about five-six whorls which increases rapidly in diameter and constitutes less than ⅓ height of shell. Spire whorls bear a row of nodes which are well elevated near suture but suppressed in the upper part of the whorl.

Body whorl large, constitutes more than ⅔ height of shell, bears a row of moderately broad nodes separated by narrower interspaces and located far below the suture; sutural ramp gently concave. Entire shell beautifully sculptured by fine spirals separated by wide interspaces; spirals located on the nodular portion of the spire whorls but covering the entire body whorl.

Interspaces bear finer secondary and tertiary spirals. Growth lines intersect the spirals to produce a fine reticulate sculpture. Columella stout and straight; bears near the apertural margin a moderately thick callosity; aperture semilunar.

Material. — One specimen.

Type. — Hypotype, UIMG No. 365.

Dimensions. — Height 21.65 mm; maximum diameter 13.2 mm.

Remarks. — This species, represented in my collection by only one but well-preserved specimen was inadequately described and figured by Furon. It closely resembles the Paleocene species of *Levifusus* from the Midway Group of the Gulf Coastal United States (Harris, 1896, pl. 19), especially *L. dalei* Harris from which it differs by its straighter columella, the heavier spines, and the finer reticulate sculpture.

From the little that can be made from Furon's figure, the illustrated holotype resembles the Nigerian specimen in whorl profile and ornamentation. It shows little or no resemblance to *Levifusus mortoniopsis* (Gabb) with which it was compared by Furon (1948, p. 109).

The continued assignment of the species to *Fusus* Bruguière is erroneous because Bruguière's name is a synonym of *Fusus* Helbling, 1779 which is a buccinid (Wenz, 1938-1944, p. 1194).

Levifusus yochelsoni Adegoke, new species Pl. 28, figs. 18, 19

Description. — Shell medium-sized, spire high, consisting of about five-six whorls which increase in diameter in steps; whorl ornamented by a median row of prominent spines, which are suppressed near the sutures. Abapical slope from suture to crest of spines more steep than the adapical slope.

Body whorl moderately large, also bearing a row of spines which produce a prominent median angulation. About nine nodes are present on both the penultimate and body whorls. Whorls ornamented by distinct, narrow spirals which are more prominent on the lower part of the whorls below the nodular crest than on the ramp above. The heaviest spiral occupies a median position across the crest of the spines; three spirals occur below and above it on each of the spire whorls whereas three occur above and ten below it on the body whorl.

Columella elongate and slender, closely sculptured by obliquely oriented spirals of unequal strength. A thin callus deposit is present. Siphonal canal long and narrow; suture narrow, indistinct.

Material. — The new species is based on the holotype only.

Type. — Holotype, UIMG No. 366.

Dimensions. — Height 34.8 mm; maximum diameter 15.2 mm.

Remarks. — This elegant species is characterized by the step-like increase in diameter of the apical whorls, the prominent median angulation of all whorls and narrow and long siphonal canal. It bears superficial resemblance to *L. irrasus* (Conrad) and *L. mortoniopsis* (Gabb). It differs from both by its more angulated spiny whorls and the finer ornamentation.

The species resembles in a general way species of the genus *Falsifusus* Grabau, 1904. It differs from them in having a shorter spire and less axially elongated nodes.

The new species is named in honor of Dr. Ellis Yochelson of the U.S. Geological Survey, Washington, D.C.

Genus **LATIRUS** Montfort, 1810

Subgenus **POLYGONA** Schumacher, 1817

Latirus? (Polygona) ewekoroensis Adegoke, new species Pl. 28, figs. 12, 15

Description. — Shell small, stout, and thick-walled. Apex acute, consisting of several whorls. Earlier whorls, straight-sided to gently convex, later whorls more strongly convex as a result of elevation of axial costae.

Body whorl high, probably constitutes up to ⅔ height of shell. Whorls sculptured by six prominently elevated, broad axial costae separated by narrower interspaces and few, equidistant, subequal spiral ribs. About five spiral ribs present on penultimate whorl and seven on the body whorl. Spiral ribs are elevated and prominently thickened on top of axial costae. Axial costae are in line from whorl to whorl but are suppressed at the sutures.

Columella thick, straight, covered by a callus. It is incomplete anteriorly, hence no plications were observed. Aperture extremely narrow, club-shaped, merging anteriorly into the incompletely preserved, narrow siphonal canal. Suture linear, largely concealed by the bases of axial costae as well as the abapical spiral rib.

Material. — The two type specimens only.

Type. — Holotype, UIMG No. 367; paratype, USNM 174866.

Dimensions. — Holotype (incomplete), height 9.50 mm; maximum diameter 4.80 mm; paratype (incomplete spire), height 4.60 mm; maximum diameter 3.05 mm.

Remarks. — This species is represented in my collection by one almost complete specimen with a broken spire. It is characterized by its small size, the few heavy axial costae, and the prominently elevated spiral ribs which are thickened where they intersect the axial costae.

The new species grossly resembles the Jamaican species described by Woodring (1928, p. 253, pl. 15) but differs by its much smaller size, the narrower aperture and the fewer but more prominently raised spirals.

Latirus? (Polygona) ewekoroensis is smaller, slenderer, less angulate, and coarser sculptured than *?L. (P.) stephensoni* Gardner (1933) from the Midway (Paleocene) of Texas.

Though columellar plications were not observed because of the incompleteness of the specimens, they were suspected to be present hence the tentative assignment of this species to *Latirus (Polygona)*.

Superfamily **CONACEA** Rafinesque, 1815

Family **TURRIDAE** H. and A. Adams

General statement. — Published information on the classification of turrids is confusing and contradictory. The problems occur not only at generic but also at suprageneric levels. Members of the group have been included by various authors within the families Turridae, Pleurotomidae, Fusidae, and Conidae (Olsson, 1929; Vincent, 1913; Newton, 1922; Beets, 1942; Rutsch, 1943; Böhm *in* Kaiser, 1926), and species have indiscriminately been assigned to the genera *Pleurotoma* (Briart and Cornet, 1871; Mayer-Eymar, 1895; Oppenheim, 1906, 1915; Salvan, 1954), *Surcula* (Newton, 1922; Woods, 1922; Hanna and Israelsky, 1925), *Clinura* (Beets, 1942; Eames, 1957), *Surculites* (Eames, 1957), *Turricula* (Böhm, *in* Kaiser, 1926), *Levifusus* (Maury, 1912), and *Fusus (Serrifusus)* (White, 1887).

The first attempt at restoring some order was by Vincent (1913) who erected the genus *Clinuropsis* for a new taxon, *C. diderrichi* which he described from the Paleocene of Landana, Congo. The designated type species was *Pleurotoma ampla* Briart and Cornet from the Calcaire Grossier de Mons. *Clinuropsis* is characterized by its large fusiform shell, the sinuous labrum and the deep growth line sinus whose point of maximum curvature is located above the row of spines (Vincent, 1913, pl. 2, fig. 8). The shell is ornamented by a few spiral ribs especially developed in the abapical portion of the whorl below the row of spines. The spines are located close to the abapical suture. To the genus may be assigned such African Tertiary species as *C. diderrichi* Vincent, *C. togoensis* (Oppenheim), and the new subspecies from Ewekoro described below as *C. diderrichi nigeriensis* Adegoke. The Trinidad species described as *C. diderrichi* by Rutsch (1943), as well as the Peruvian *C. thompsoni* (Olsson, 1929), also belong to *Clinuropsis* though they should more appropriately be assigned to new subspecies.

The morphological characters of the geographically widespread Eocene species, *Clinuropsis ingens* (Mayer-Eymar) seemingly conform more closely with those of *Clinuropsis* than those of the genera *Surcula, Surculites, Clinura,* and *Pleurotoma* to which it had frequently been assigned by most earlier workers (Caster, 1938; Olsson, 1929; Beets, 1942).

Olsson (1929, p. 28) erected the genus *Andicula* for a few smooth Peruvian species which seem closely related to *Clinuropsis*. He stressed the combination in this taxon of both pleurotomoid and fusoid characteristics and designated *Surcula occidentalis* Wood as type species. In *Andicula,* the growth line sinus is as deep but narrower than in *Clinuropsis,* its point of maximum inflection coincides with the position of the row of spines, and the spines are located higher above the suture. In addition, the columella is stouter, the body whorl more inflated and the shell smoother than that of *Clinuropsis*. *Andicula* is considered as a valid genus here.

Two other African species are known which cannot be referred to any of the genera discussed above, *viz. Turricula excelsa* Böhm (1926) described from the Diamond fields at Bogenfels, Southwest Africa, and the new species described as *Vincenturris woodringi* from the Ewekoro quarry. Both are characterized by the possession of a large heavy shell with a moderately high spire; the body whorl is large and inflated, the growth line sinus is shallow and broadly curved with point of maximum inflexion occurring above the row of nodes. Besides, the shells are reticulately sculptured. Both are here referred to *Vincenturris* Adegoke, new genus.

Böhm (*op. cit.*) assigned the African species to *Turricula* and included *Clinuropsis* Vincent within the same genus. Beet's (1942) usage was ambiguous. He referred both the species referred by Vincent as *Clinuropsis* and by Böhm as *Turricula* to *Clinura* which he treated sometimes as a genus and often as a subgenus of *Surculites*. Rutsch (1943, p. 181) emphasized the distinctness of *Turricula excelsa* Böhm.

Genus **VINCENTURRIS** Adegoke, new genus

Diagnosis. — Shell fusiform to pyriform, with moderately high spire and a large body whorl constituting more than half the height of the shell. Whorls bear a row of closely packed short, heavy spines located on the lower third of each spire whorl and on the upper third of the body whorl. Columella stout, straight, slightly curved at the tip and bearing a heavy deposit of callus. Siphonal canal narrow and obliquely oriented.

Shell ornamented by numerous primary, secondary, and tertiary spirals. Growth line sinus shallow and gently curved, point of maximum depth coincides with the position of the spines. The new genus is named in honor of E. Vincent.

Type species: *Vincenturris woodringi* Adegoke, new species.

Vincenturris woodringi Adegoke, new species Pl. 29, figs. 1-4

Description. — Shell large, turriform, consisting of a moderately high spire composed of about six-seven whorls (apex broken) which expand in diameter rapidly. Each whorl ornamented by a row of laterally expanded spines which are located in the abapical third of each whorl; ramp above the spines slightly excavated bearing a few faint spirals.

Body whorl large, constituting about ⅔ height of shell, bearing a closely packed row of spines located far below the suture. Shell ornamented by several heavy spirals in the interspaces of which are less prominent secondary, tertiary, and quaternary spiral threads. Columella stout, straight, slightly bent anteriorly, with a well-developed, siphonal fasciole. Siphonal canal narrow and long. Growth line sinus shallow, broad, and gently curved. Heavy callus deposited on columellar lip on adult specimens. Aperture small for size of the shell, elongate-oval in outline.

Material. — Two specimens.

Types. — Holotype, UIMG No. 368; paratype, USNM No. 174867.

Dimensions (mm). —

	height	maximum diameter
UIMG 368	67.20	39.10
USNM 174867	51.65	34.15

Remarks. — This species may be readily distinguished from *Vincenturris excelsa* (Böhm), here reassigned to the new genus by its less inflated shell and the ornamental pattern in which secondary, tertiary, and quaternary ribs of varying sizes are intercalated between the prominent primary spirals. The aperture is much smaller and more oval and the columella stouter. One of the specimens referred to *C. diderrichi* Vincent by Tessier (1952, pl. 38, figs. 4-5 only) belongs to this genus.

The new species is named in honor of Dr. W. P. Woodring, Smithsonian Institution, Washington, D.C.

Genus **CLINUROPSIS** Vincent, 1913

Clinuropsis togoensis (Oppenheim) Pl. 29, figs. 5-10

Pleurotoma togoensis Oppenheim, 1915, p. 59, pl. 5, fig. 5.
Clinuropsis togoensis (Oppenheim), Furon, 1948, p. 110, pl. 9, fig. 17; Adegoke, 1972a, pl. 3, fig. 5.

Description. — Shell medium-sized, conoidal; spire short, funnel-shaped, consists of about six-seven low whorls which are gently concave above, and sharply elevated, and spinose abapically. Each whorl bears 10-12 laterally elongate, low spines with a narrow gap between spine bases and the suture. Few fine threads adorn the spire whorls.

Body whorl relatively large, forming an inverted cone which terminates at the tip of the columella; bears in the adapical third a crown of 12-15 low, flat spines; space between spine and suture gently concave, prominently marked by large sinuous growth lines with point of maximum curvature located just above the spines; body whorl ornamented by about 10 spirals which are more prominent on the parietal face of the body whorl. Columella narrow, elongate, tip gently curved, covered by a thin callus. Siphonal canal narrow and bent.

Material. — About 50 complete specimens.

Type. — Hypotypes, UIMG Nos. 144, 369-371, USNM 174868, 174869.

Dimensions (mm). —

	height	maximum diameter
UIMG 144	34.50	17.75
UIMG 369	37.80	19.65
UIMG 370	16.60	12.30
UIMG 371	22.45	14.40
USNM 174868	31.95	19.15
USNM 174869	30.75	15.60

Remarks. — This is a common species at Ewekoro. It is represented by over 48 complete specimens. The species shows considerable variation in the degree of inflation of whorls and height of spire. The growth line trace with the deep sinus coinciding with the position of the row of spines confirm the placement of the species within *Clinuropsis.*

The type species of the genus, as well as most of the specimens referrable to the genus, have so far been recognized in Paleocene strata from Togo (Oppenheim, 1915; Furon, 1948); Ghana (Cox, 1952); Senegal (Tessier, 1952, p. 394) and Trinidad (Rutsch, 1943). The genus thus appears to be a good Paleocene index form in West Africa.

Clinuropsis diderrichi Vincent **nigeriensis** Adegoke, new subspecies
Pl. 29, figs. 11-14

?*Clinuropsis diderrichi* Vincent, Tessier, 1952, p. 394, pl. 38, fig. 9 (only); Chabaglian, 1959, p. 149, pl. 2, fig. 7.

Clinuropsis diderrichi Vincent, n. subsp., Adegoke, 1972a, pl. 3, figs. 13, 20.
Clinuropsis diderrichi Vincent, Adegoke, 1972b, pl. 1, fig. 12; 1973, fig. 1.

Description. — Shell large, fusiform, spire short, consisting of about seven whorls, spire whorls high, slightly excavated adapically, sloping anteriorly terminating in a row of about 9-10 short blunt spines whose bases are situated on the suture.

Body whorl large, sloping gradually from suture to a prominent shoulder which bears about nine heavy spines. Spine bases interconnected by lateral ridges. Body whorl tapers rapidly below spines, faintly marked by the spiral threads and the sinuous growth lines; upper sinus broad and fairly deep, maximum depth occurs above the row of spines. Columella heavy, elongate, cylindrical, and smooth. Suture sinuous, deflected slightly to accommodate the bases of spines.

Material. — Three specimens.

Types. — Holotype, UIMG No. 154; paratype, UIMG No. 153, USNM No. 174870.

Dimensions (mm). —

	height	maximum diameter
UIMG 153	47.45	39.65
UIMG 154	51.90	38.50
USNM 174870	41.20	31.55

Remarks. — The diagnostic features of this new subspecies are its large shell and that the spines abut on the suture and the upper part of the following whorl.

It may be distinguished readily from *C. togoensis* (Oppenheim) by its larger size, the relatively shorter but more robust shell, and the fewer, heavier nodes. In Oppenheim's species, the rows of spines are located some distance above the suture.

The new subspecies is similar in dimensions to the Trinidad specimens referred to *C. diderrichi* by Rutsch (1943, p. 180, pl. 5, figs. 5-7). In the latter the suture is more deeply incised, the spines do not abut on the suture, and the whorls bear more spiral ornamentation than on the Nigerian subspecies.

The specimens figured by Tessier (1952) from the Paleocene of Marigot de Balling, though more conspicuously ornamented resemble the present subspecies (see especially Pl. 38, fig. 9) in that the spines not only abut on but also cause a deflection of the sutures. They are here questionably referred to the Nigerian subspecies.

The new subspecies is represented in my collection by three specimens.

Genus **TURRICULA** Schumacher, 1817

Subgenus **TURRICULA** s.s.

Turricula (Turricula) nigeriensis Adegoke, new species Pl. 30, figs. 1-4

Description. — Shell minute, turriculate; maximum adult height about 6.85 mm. Spire moderately high, obtuse, consisting of about five low whorls. Protoconch and earliest three whorls smooth, robust, and uniformly convex. Later spire whorls adorned by five, broad, moderately inflated nodes which abut on the abapical suture but fail to reach the adapical suture thereby producing a riblike unnoded adapical band. Axial nodes more or less in line from whorl to whorl.

Body whorl high, constituting about 3/5 height of shell. Sculptured by elongate, axial costae which are slightly curved and are oblique with respect to shell axis. Seven axial costae adorn the adult body whorl. Apart from axial nodes, the entire shell is finely sculptured reticulately by numerous axial and spiral threads. Superimposed on these are the sinuous growth striae with a deeply curved antispiral sinus just adapical to the row of nodes.

Columella is wide at the base and tapers uniformly to a pointed anterior end. Aperture elongate, club-shaped, opening anteriorly into a short, wide, slightly recurved anterior siphonal canal.

Material. — The type specimens only.

Type. — Holotype, UIMG No. 372; paratype USNM No. 174871.

Dimensions (mm). —

	height	maximum diameter
UIMG 372	6.85	2.95
USNM 174871	6.55	2.75

Remarks. — This species is characterized by its small size, its inflated spire, the elongate, slightly curved body whorl nodes, and the fine reticulate microsculpture.

It may be readily distinguished from the associated, similar-sized *Turricula (Turricula) ewekoroensis* Adegoke, new species which is smooth, with fewer, more inflated, dome-shaped axial nodes, and straighter, parallel-sided columella and narrower siphonal canal.

The species is smaller with more extensive nodes than the Copenhagen species referred to *Surcula* by Ravn (1939).

Apart from its much smaller size, *Turricula (Turricula) nigeriensis* Adegoke, new species bears superficial resemblance to the Claibornian taxon, *Turricula (Pleurofusia?) huppertzi* (Harris, 1937, p. 52, pl. 10). Its reticulate microsculpture is finer and more evenly developed.

Turricula (Turricula) ewekoroensis Adegoke, new species
Pl. 30, figs. 5, 6

Description. — Shell small, turriculate; maximum adult height about 6.25 mm. Spire high, narrow, and acutely pointed, consisting of about 5½ moderately high whorls. Protoconch and earliest 2½ nuclear whorls gently convex and smooth. Subsequent spire whorls bear six inflated, dome-shaped costae which abut on the abapical suture but are suppressed adapically. Axial costae in line on all spire whorls except the penultimate whorl.

Body whorl moderately high and inflated less than half height of shell, sharply constricted at the base, ornamented by five high, inflated nodes separated by broad U-shaped interspaces. No trace of spiral sculpture was observed. Columella stout, cylindrical. Aperture small, hemispherical eccentric, widest near the apical end. Siphonal canal incomplete, probably long and narrow. Suture linear, wavy around base of nodes.

Material. — The holotype only.

Type. — Holotype, UIMG No. 373.

Dimensions. — Height 6.25 mm; maximum diameter 3.00 mm.

Remarks. — This species, though similar in size to *T. (T.) nigeriensis* Adegoke, new species may be readily distinguished by its more elongate, acute spire, the more inflated, dome-shaped axial costae which decrease in number on the body whorl, the more conspicuous constriction of the base of the final whorl, the elongate cylindrical columella, the narrower siphonal canal, and the absence of spiral sculpture.

Genus SURCULITES Conrad, 1865

Surculites kogbei Adegoke new species Pl. 30, figs. 7-11

Description. — Shell medium-sized, slender and elongate. Spire high, consisting of about seven-eight whorls which are sharply angulated about the middle. Youngest apical whorls bear on their raised abapical end about eight rounded nodes which are crossed by three fine, equidistant spiral threads. Row of nodes bounded adapically by a shallow, broad groove in which the growth line sinus is deeply curved. Later spire whorls straight-sided abapically.

Body whorl high, about half the height of the shell with a prominent adapical angulation. Adapical margin gently concave with a well-developed anal sinus terminating at the angulation, below which the whorl tapers gently to a pointed columella and narrow siphonal canal. Body whorl ornamented by broad, flat-topped spirals separated by narrow interspaces. Spiral sculpture more prominent near the anterior tip. Columella long, tapering only gently with a thin callus. Aperture narrow, elongate, with subparallel margins.

Material. — Six well-preserved specimens.

Types. — Holotype, UIMG No. 374; paratypes, UIMG No. 375, USNM Nos. 174872, 174873.

Dimensions (mm). —

	height	maximum diameter
UIMG 374	35.00	13.25
UIMG 375	30.1	12.20
USNM 174872	30.8	12.7
USNM 174873	23.1	10.4

Remarks. — The diagnostic features of this species are its narrow slender form and the prominent median angulation of the body and spire whorls.

The new species closely resembles Conrad's (1865) figured type species (Harris, 1937, p. 63, pl. 11, fig. 20; Wenz, 1938, p. 1390, fig. 3927), hence the present generic assignment. It differs in having the angulation lower down on the whorls and in being more coarsely ornamented.

The new species is less spirally ribbed than most of the American forms illustrated by Harris (1937).

Surculites kogbei most closely resembles *Surcula (Ancistrosyrinx) vredenburgi* Cossmann and Pissarro (1909, p. 10, pl. 1, figs. 29, 30) from the lowermost beds of the Upper Ranikot of India.

It differs by the more prominently developed axial nodes on the earliest apical whorls, its relatively shorter, more uniformly tapered spire, and the relatively higher and wider body whorl.

The new species is named in honor of Dr. C. A. Kogbe, Department of Geology, University of Ife, Nigeria. The holotype was collected by Dr. Barry Pass.

Superfamily **VOLUTACEA** Fleming, 1822

Family **OLIVIDAE** Swainson, 1840

Subfamily **AGARONIINAE** Olsson, 1956

Genus **AGARONIA** Gray, 1839

Agaronia togoensis Furon Pl. 30, figs. 12-15

Olivancillaria (Agaronia) togoensis Furon, 1948, p. 110, pl. 9, fig. 18.

Description. — Shell medium-sized, spire moderately high, with about five-six telescoped whorls. Earliest spire whorls have gently sloping walls, last spire whorl slightly concave with maximum depression about the middle of the whorl; suture distinct, deeply channelled.

Body whorl high, constituting more than ⅔ height of the shell, wall more or less straight adapically, narrowing gradually in the lower portion. Body whorl smooth but for growth lines. Siphonal canal short and wide. Columella stout, broadly folded, tapers gradually to a blunt anterior end, bisected about the middle by a prominent spiral ridge whose upper limit is marked by an equally prominent spiral groove; the lower lobe of the columella bears a thinner, less prominent spiral plication and another distinct spiral ridge, flanked on both sides by shallow depressions the upper of which bears a faint ridge which bisects the lower lobe of the columella. Parietal calus thin, spreads upward and covers the lower half of the preceding whorl.

Material. — This species is abundantly represented by about 34 mostly complete specimens.

Types. — Hypotypes, UIMG Nos. 376, 377, USNM Nos. 174874, 174875, PRI Nos. 29821-29823.

Remarks. — The general characters of this species, especially the high spire, the columellar ridges, and grooves as well as the banding of the anterior margin distinguishes it from species of most related genera especially *Oliva, Olivella, Agaronia, Olivancillaria, Ancillaria,* and *Terebellum.* It resembles the latter superficially in that the callus continues as a spiral band up the spire (Jung and Abbott, 1967), but the spire is much higher.

The West African species differs from the Indian species *Olivancillaria birmanica, O. (Agaronia) pagodula,* and *O. (Agaronia) cossmanni* (Vredenburg, 1923) by its higher less excavated spire the less prominent columellar plications, and the less robust shell.

Family **MARGINELLIDAE** Fleming, 1828

Genus **CRYPTOSPIRA** Hinds, 1844

Cryptospira, new species Pl. 28, fig. 14

Description. — Shell small, spire small, consisting of about three-four smooth whorls, which merge insensibly into one another. Suture hairlike, virtually invisible. Lower part of last spire whorl covered by callus.

Body whorl large and elongate, constituting more than 90 per cent height of entire shell, completely smooth but for fine growth striae. Anterior two-thirds of the columella beautifully sculptured by seven subparallel plications which increase in prominence towards the anterior end; last plication forms the inner border of the short and wide siphonal canal. A spiral line from the middle plication revolves round columella defining an inconspicuous, slightly elevated siphonal fasciole, against which the growth line striae make a sharp turn toward the aperture.

Inner margin of the outer lip bears a row of 12 subequal transverse ridges which are slightly elevated near the outer rim and end abruptly before reaching the outer margin. Interspaces between these ridges are finely striated. Swollen outer lip margin not completely preserved. A thin callus covers the columella and part of the parietal surface. Aperture narrow, crescentic-elongate.

Material. — One specimen only.

Types. — Hypotype, UIMG No. 378.

Dimensions. — Height 3.78 mm; maximum diameter 1.96 mm.

Remarks. — This elegant species was represented in my collection by a single well-preserved specimen.[2] It is different from most described species of *Cryptospira* not only in the possession of seven

[2]The spire and most of the body whorl of this specimen crumbled during photographic preparation. Only the columella was preserved. The description was based on the complete specimen.

columellar plications but also because these plications are subparallel to one another. Collection of additional specimens would enable the formal naming of the new species and may warrant its recognition as a separate subgenus.

The specimen resembles *Cryptospira birmanica* Vredenburg (1923, p. 254, pl. 14, fig. 11) from the Tertiary of India but differs by its narrower shell, and the more parallel plications. It also resembles the Paris Basin Bartonian *Cryptospira (Gibberula) suboliva* Cossmann, differing only by its more elongate anterior canal and the less oblique anterior plications. The latter species was doubtfully recorded by Salvan (1954, p. 213 as *Marginella (Cryptospira)* from the Lutetian of Morocco.

The species resembles *Marginella dalliana* Maury (1912, p. 67, pl. 10) from the upper Oligocene of Trinidad in outline but is less inflated and bears seven columellar plications as against four in the Trinidad species.

This record is the oldest known for the genus *Cryptospira.*

Family **VOLUTIDAE** Fleming, 1822

Subfamily **VOLUTINAE** Fleming, 1822

Genus **VOLUTILITHES** Swainson, 1831

General statement.— There has been much controversy in the literature over the generic placement of many volutid species, especially those belonging to the genera *Volutilithes* Swainson (1831), *Athleta* Conrad (1853), and *Volutocorbis* Dall (1890).

Much of the problem centered around erroneous type designations and was reviewed by Newton (1906), Stewart (1926), Palmer (1937), and more recently by Fisher and others (1964).

Voluta muricina is now generally accepted as the type of *Volutilithes* and *Eopsephaea* Fischer (1883) is considered as a synonym of the latter. Fisher and others (1964, p. 36) raised fundamental issues which might invalidate Swainson's name thereby making *Eopsephaea* the correct name for this genus-group. The American species previously assigned to *Volutilithes, Voluta,* and *Plejona* (Smith, 1906; Conrad, 1934; Deussen, 1924, pl. 14, figs. 4, 5) would thus belong to *Athleta* Conrad, 1853 (Palmer and Brann, 1966; Fisher and others, 1964).

Two species within this genus-group were recorded from the

Paleocene of Togo. The first, named *Volutilithes gruneri* by Oppenheim (1915) was subsequently assigned to *Athleta (Volutocorbis)* by Furon (1948). In the same work, Furon described a second species as *Volutilithes (Neoathleta?) uniplicata.* Both species are represented in the Ewekoro fauna, the former by a single specimen, the latter by over 50 specimens.

Because of the uncertain generic status of these species, the generic characters of the closely related European and American species were re-examined.

The Nigerian specimens show closest affinity to species referred to *Volutilithes* Swainson, a genus characterized by possession of one prominent columellar fold and several minor and obsolete ones separated from the major fold by a deep groove (Swainson, 1831; Newton, 1906; Fisher and others, 1964). All the other genera (*e.g. Athleta, Volutocorbis, Volutospina, Neoathleta*) have at least two or more prominent columellar folds (Fisher and others, 1964).

In the two West African species under consideration, only one major columellar plication is developed. Posterior to this and located much farther inside the shell, are two extremely faint, flat-topped spirals. The two species thus differ markedly from typical *Volutilithes* in the absence of a deep groove between the major and minor plications. Because of these fundamental differences, the West African species are here referred to a new subgenus, *Afrovolutilithes* Adegoke for which Furon's species, *V. uniplicata* is designated as type.

A third species from Ewekoro with two unequal plications separated by a shallow groove, located on a columellar pad is here assigned to *Volutocorbis.*

Subgenus **AFROVOLUTILITHES** Adegoke, new subgenus

Diagnosis. — Medium-sized volutids, much like *Volutilithes* Swainson, 1831, but shorter-spired. Columella tapers gradually to a narrow, slightly flexed anterior end, bears one strong plication anteriorly and two flat inconspicuous spirals posteriorly not separated by a deep groove. Adult sculpture variable, consisting usually of strongly developed axial ridges and finer spiral ribs. A thin callus may or may not be present on the columella and parietal surface.

Type species. — *Volutilithes (Afrovolutilithes) uniplicata* Furon.

Volutilithes (Afrovolutilithes) uniplicata Furon Pl. 30, figs. 16-19

Volutilithes (Neoathleta?) uniplicata Furon, 1948, p. 110, pl. 9, fig. 16.
Volutilithes sp. Chabaglian, 1959, p. 162, pl. 3, figs. 10, 11.
Volutilithes uniplicata Furon, Adegoke, 1972a, pl. 3, figs. 11, 15; 1972b, pl. 2, fig. 3.

Description. — Shell medium, spire short, acute, consisting of about six whorls which are angulated above, sloping gently and merging with the slightly convex sides. Spiral suture obscured by secondary calcite development.

Spiral whorls ornamented by numerous axial ribs which run the entire length of the whorl, the axial sculpture decreases in number on older whorls, about 25-30 present on the 4th whorl, 17-18 on the 5th, and 11-15 on the penultimate whorl. Fine revolving striae are superimposed on the axial sculpture.

Body whorl large and elongate, constituting about ¾ height of entire shell, flat above the angulation, and ornamented by about 12 axial costae which are angulated above. Costae subdued near the anterior border of body whorl where spiral sculpture is dominant (Pl. 30, fig. 16) they are flexed almost at right angles as they approach the siphonal fasciole finally running in a direction parallel to the anterior tip of siphon.

Body whorl ornamented by broad revolving ribs which are extremely faint and often almost invisible on upper body whorl, becoming more prominent on the anterior portion of body whorl. Columella stout and elongate, bears a strong median spiral plication. Columella and parietal surface covered by a thin callus which also covers the lower third of the penultimate whorl and the bases of most of the spiral whorls. Outer lip rim thickened.

Material. — Thirty-six adult and 14 juvenile specimens.

Types. — Hypotype, UIMG Nos. 379, 380, USNM Nos. 174876, 174877, PRI Nos. 29807, 29808.

Dimensions (mm). —

	height	maximum diameter
UIMG 379	26.35	13.55
UIMG 380	20.70	10.00
USNM 174876	16.00	7.60
USNM 174877	20.60	10.25

Remarks. — This elegant species occurs abundantly at Ewekoro. Over 36 complete adult and 14 juvenile specimens were collected. The species shows an unusual pattern of axial sculptural development not common among mollusks. The axial ribs are more numerous at first appearance and decrease on the more adult whorls. In these specimens, axial sculpture was first noticed on the 2nd to 3rd whorl. Here they were numerous but too fine to count, on the 4th whorl between 25 to 30 were counted, most shells having almost 30 or more. The number decreases to about 18 on the fifth whorl and about 15 on the last spire whorl. The body whorl bears only about 12.

The new species differs from *L. citrusensis* Palmer *in* Richards and Palmer (1953) by the more prominent angulation of the whorls and the less convex body whorl.

Volutilithes (Afrovolutilithes) gruneri Oppenheim Pl. 30, figs. 20, 21

Volutilithes gruneri Oppenheim, 1915, p. 56 (in part), pl. 5, figs. 2-3 (only, not fig. 1 = *V. oppenheimi* Adegoke, new species) ; Adegoke, 1972a, pl. 2, fig. 4; 1972b, pl. 2, fig. 9.
Athleta (Volutocorbis) gruneri Oppenheim, Furon, 1948, p. 109, pl. 9, fig. 14.

Description. — Shell small, narrow, elongate. Spire elevated constituting about ¼ height of shell and consisting of about six-seven whorls which increase in diameter step-wise as added.

Body whorl elongate, with an elongate-oval aperture about ⅔ height of shell. Spire and body whorl sculptured by about 15-16 prominent axial costae which are intersected by narrow spiral ribs producing a noded appearance. About 15 spiral ribs present on the body whorl. Columella stout with a broad adapical end, slightly bent with one major plication at the point of inflexion.

Material. — One specimen.

Type. — Hypotype, UIMG No. 131.

Dimensions. — Height 12.1 mm; maximum diameter 6.5 mm; height of aperture 9.1 mm.

Remarks. — This species is represented in my collection by a single well-preserved specimen. Its gross characteristics compare closely with those of the type specimen described from Togo by Oppenheim (1915). It differs in having fewer costae and spiral ribs on the body whorl, the spire is slightly higher and the siphonal canal wider.

Only one prominent columellar plication is developed in this species (Oppenheim, 1915, pl. 5, fig. 3). It is located medianly at the point of inflection of the columella. About three weak spirals are present adapical to the plication. These are mere extensions of the normal spiral ribs on the parietal surface. Their prominence is obscured by the deposited callus.

Volutilithes (Afrovolutilithes) oppenheimi Adegoke, new species
Pl. 30, figs. 25-26

Volutilithes gruneri Oppenheim, 1915, p. 56 (in part), pl. 5, fig. 1 (only).

Description. — Shell small, elongate. Spire high, obtuse, consisting of about five whorls which increase gradually in diameter as added. Nucleus consists of about 2½ smooth, convex whorls. Later whorls gently convex, ornamented by several broad, oblique, axial costae which are crossed by narrower, closer-set spiral ribs which are separated by narrow interspaces.

Body whorl large and elongate, constituting in the holotype the greater proportion of the shell; gently constricted at the base producing an elongate siphonal canal. Columella stout, deflected anteriorly. Outer lip expanded in the middle producing a moderately wide aperture which is sharply constricted at its anterior limit as it enters the narrow siphonal canal. Columellar plication not visible exteriorly.

Material. — One specimen.

Types. — Holotype, specimen from Togo figured by Oppenheim (1915, pl. 5, fig. 1); paratype, UIMG No. 382.

Dimensions. — Height 9.00 mm; maximum diameter 5.75 mm (paratype).

Remarks. — This species is similar superficially and is probably closely related to *Volutilithes (Afrovolutilithes) gruneri* Oppenheim. The specimen illustrated by Oppenheim (1915) as *V. gruneri* (pl. 5, fig. 1) is here selected as the holotype. A single additional specimen was collected in this study from the Ewekoro quarry.

The new species is characterized by the uniform increase in the diameter of its apical and body whorls producing a smooth apical taper as distinct from the steplike increase in diameter of the apical whorls of *V. (A.) gruneri*. The spire whorls are gently convex and bear no shoulders; the sculpture consists of laterally extended, broad axial costae which contrast sharply with the narrower, more numerous axial costae of *V. (A.) gruneri* (compare Oppenheim's figures 1 and 2). In addition, the spiral ribs of the new species are thicker, closer-set, and are separated by narrower interspaces than those of *V. (A.) gruneri.*

The columella of the new species is more elongate, cylindrical, more sharply bent and the plication fails to reach the exterior; the aperture is more oval and wider medially and the siphonal canal narrower and more bent than in *V. (A.) gruneri.*

The new species is named in honor of P. Oppenheim.

Genus **VOLUTOCORBIS** Dall, 1890

Volutocorbis furoni Adegoke, new species Pl. 30, figs. 22-24

Description. — Shell small, short. Spire short and robust, consisting of a protoconch and about 2-2½ smooth, inflated nuclear whorls. Last spire whorl bears about 22 axial ribs separated by interspaces of about equal width, faintly crossed by six transverse ribs separated by shallow and narrow grooves.

Body whorl large, constituting more than two-thirds height of shell, reticulately sculptured by axial and transverse ribs of approximately equal width which form minute nodes at their point of intersection. Columella short and stout bearing a heavy broadly rounded plication anteriorly, separated by a shallow groove from the faintly elevated posterior plication. Anterior siphonal canal short, moderately wide and slightly recurved. Labrum broadly and smoothly arched bearing five narrow denticles interiorly. Denticles do not reach the external labral margin.

Material. — Two specimens.

Types. — Holotype, UIMG No. 383; paratype, USNM No. 174878.

Dimensions (mm). —

	height	maximum diameter
UIMG 383	6.5	3.8
USNM 174878	4.2	2.5

Remarks. — This species is represented by two incomplete specimens. The holotype is fragile and was bored by a predator. They are assigned to *Volutocorbis* because of the ontogeny — a protoconch and nuclear whorls of about 2-2½ smooth, inflated whorls followed by the reticulately sculptured postnuclear whorls which bear short nodes at the intersection of axial and spiral sculpture (Fisher and others, 1964, p. 37, text-fig. 27), the stout columella with two spiral plications, the wide, slightly recurved anterior canal, and the uniformly curved labrum bearing about five denticles. The spire of the new species is shorter and the body whorl slightly more inflated adapically than in the typical form, *V. limopsis* (Conrad) figured by Fisher and others (1964). The columellar plications are interior and the body whorl has to be partially dissected to expose them.

The columellar plications are located on a swollen pad, similar to the situation in the species of *Volutilithes* here assigned to *Afrovolutilithes*. It appears reasonable then to assume that the latter evolved from *Volutocorbis* by development of additional fine plications adapically. The insignificantly shallow nature of the groove between the plications in the new species and its close comparison with the identical feature in *Afrovolutilithes* further support this contention. It should be remembered that in typical *Volutilithes*, the anterior plication is separated from the posterior ones by a deep groove (Fisher and others, 1964).

Genus **VOLUTA** Linnaeus, 1758

Voluta africana Adegoke, new species Pl. 30, figs. 27-29

Description. — Shell small for genus, short, thick-walled. Spire short, incompletely preserved consisting of low but wide whorls. Ornamented by six rows of prominently raised axial ridges which are highest at the abapical end, sloping gradually to about ⅔ height of whorl where it drops abruptly producing a conspicuous angulation. Body whorl large incompletely preserved on types, ornamented by six well-raised axial ridges which produce an angulation near the adapical end. Axial ribs are continuous from whorl to whorl.

Columella large for size of shell, conical-cylindrical, tapering to a pointed anterior end. Ornamented by four prominent columellar plications, of which the posterior three are subequal and subparallel. The last is slightly smaller and runs obliquely to the other three. All four plicae terminate along a vertical line on the exterior of columella. A thin callus covers the columella.

Material. — Two specimens.

Types. — Holotype, UIMG No. 384; paratype, USNM No. 174879.

Dimensions (mm). —

	height	maximum diameter
UIMG 384	6.65	4.55
USNM 174879 (broken columella only)		

Remarks. — This new species is grossly comparable to the type species, *V. musica* Linnaeus (Wenz, 1938-44, p. 1330, fig. 3775) from which it differs only by its smaller size, the few axial ridges, and the fewer columellar plications.

The new species may be readily distinguished from *Voluta radix* Oppenheim (1906, p. 328, pl. 24, fig. 8) and *V. sanurensis* Oppenheim (1906, p. 328, pl. 24, figs. 21a, b) because the latter have more axial costae and more sharply angulated whorls.

The present record shows that the genus *Voluta s.s.* had its origin at least as far back as the Paleocene.

Genus **PSEUDAULICINA** (Chavan M.S.), Furon, 1948

Pseudaulicina simplex (Furon) Pl. 31, figs. 1-4

Lapparia (Pseudaulicina) simplex Furon, 1948, p. 109, pl. 9, fig. 15.
Pseudaulicina simplex (Furon), Cox, 1952, p. 51, pl. 5, figs. 13a, b.

Material. — Over 143 specimens.

Types. — Hypotypes, UIMG Nos. 385, 386, USNM Nos. 174880, 174881, PRI Nos. 29809, 29810.

Dimensions (mm). —

	height	maximum diameter
UIMG 385	39.45	28.90
UIMG 386	19.10	18.70
USNM 174880	22.50	14.00
USNM 174881	14.50	7.55

Remarks. — This is one of the most abundant species represented at Ewekoro. Over 143 specimens were collected. The sample is thus considered ideal for examining variability within the population.

Though Furon's (1948) original description and Cox's (1952) later recognition of the species were based on a few specimens, they recognized the variability of the species (Cox, 1952, p. 52). There is marked variation in the shape of the shell, height of spire, number and prominence of spines on the body whorl and spire.

The generic position of the species has also been controversial. It was assigned to the genus *Lapparia* in Furon's (1948) description. He employed *Pseudaulicina,* a name first proposed in an unpublished manuscript by Chavan as a subgeneric name. According to Furon (*op. cit.*), Chavan's type species is *Voluta musicalis* Lamarck from the Lutetian of the Paris Basin (Cossmann and Pissarro, 1904-1906, pl. 45, fig. 206-1).

Pseudaulicina was used and accorded generic status by Cox (1952) who cited Furon (1948) as the authoritative source. The same name was later used, though as a subgenus by Tessier (1952).

Pseudaulicina differs so markedly from the American Tertiary species of *Lapparia* (Palmer, 1937; Palmer *in* Harris and Palmer, 1946) that its inclusion as a subgenus of *Lapparia* is unwarranted. Species of *Aulicina* similarly lack spines and thus cannot be considered as proper representatives of the genus group. For these reasons, Cox's elevation of *Pseudaulicina* to generic rank is accepted here.

Family **MITRIDAE** Swainson, 1831

Subfamily **VEXILINAE** Thiele, 1929

Genus **CONOMITRA** Conrad, 1865

Conomitra guineensis Adegoke, new species Pl. 31, figs. 5, 6

Caricella, n. sp. Adegoke, 1972a, pl. 3, fig. 17.

Description. — Shell medium-sized, moderately inflated and elongate; spire short, consists of five relatively low whorls with convex walls which merge smoothly into one another; ornamented by about 19 narrow, faintly elevated, slightly oblique axial ridges separated by interspaces which are as wide as the ribs. Spiral suture conspicuous, linear.

Body whorl elongate, constituting about 4/5 height of the entire shell, ornamented by faint axial ridges which run down most of the height of whorl. Outer lip margin broken but thick. Columella stout, bears four coarse transverse plications which are perpendicular to the columellar axis; plications decrease in length anteriorly.

Columella tip has well-deveoped siphonal fasciole and a small pseudumbilicus. Siphonal canal short.

Material. — The new species is based on the holotype only.

Type. — Holotype, UIMG No. 156.

Dimensions. — Height 22.9 mm; maximum diameter 10.7 mm; height of aperture 14.4 mm.

Remarks. — This species is known from one well-preserved specimen. It is characterized by the elongate, moderately inflated shell, the irregular and oblique axial ridges, and the four subparallel columellar folds which are perpendicular to the shell axis.

The new species resembles American species of *Conomitra* figured by Palmer (1937, pl. 66, fig. 26), Richards and Palmer (1953), and Cernohorsky (1970, pl. 14, fig. 2), especially the type species, *C. fusoides* Lea. It may be readily distinguished by the absence of spiral sculpture, the narrower shell, the heavier columella, and the presence of a pseudumbilicus.

It differs also from most figured Paris Basin and European species (Cossmann and Pissarro, 1910-1913, pl. 42; Cernohorsky, 1970, pl. 14) by the lack of spiral ornamentation, the much finer axial sculpture, and the less oblique columellar plications.

Conomitra guineensis Adegoke, new species resembles in general outline and absence of spiral sculpture the species *Caricella ogliviana* Maury and *C. perpenguis* Maury (1912) from the Paleocene Soldado Formation of Trinidad. They differ by the possession of axial sculpture.

Apart from a doubtful Cretaceous record, the oldest undoubted record of the genus is from the Paleocene (Cernohorsky, 1970, p. 105). It probably occurs in the Danian Calcaire de Faxe [Ravn, 1933 as *Turricula (Fusimitra)*]. This Nigerian occurrence shows that the genus has an extensive geographic range during the Paleocene.

Family **VANPALMERIIDAE,** new family

Diagnosis. — Small-sized, biconic volutids with short spire which is completely covered by several layers of secondary calcareous deposits with a laminar, feltlike texture. Orientation of laminae vary from layer to layer with two preferred directions, subaxial and transverse. Interior and outermost calcareous layers thin, extremely glossy (Pl. 31, figs. 7-10) and of a dead white color.

Body whorl narrow, high, probably constituting more than three-fourth height of shell and completely covered by the glazed outer calcareous layer. Columella long and narrow with an expanded adapical portion, a straight medial portion bearing three subequal and parallel oblique plications, and a slightly deflected anterior end. Aperture narrow, elongate-oval, merging insensibly into the moderately wide, parallel-sided anterior canal.

Remarks. — This family is erected to accommodate this unusual, elegant species, unique in that the entire shell is covered by successive layers of feltlike calcite, the outermost and innermost of which is smoothly glazed.

Genus **VANPALMERIA** Adegoke, new genus

Diagnosis. — Shell small, biconic. Spire short, completely covered by several layers of secondary calcareous material with a laminar felt-like texture. Laminae have different orientations from layer to layer, innermost and outermost layers smoothly glazed, exterior streamlined. Number of spire whorls unknown. Partially dissected specimen shows that whorls were originally convex with impressed suture. Inner layers of calcareous cover completely fills all topographic features of the shell producing a streamlined exterior.

Body whorl apparently high, also covered. Aperture elongate-oval, widest diameter coincides with upper flexure of columellar lip. Columella bears in the median portion three narrow and subequal plications. Anterior end of columella flexed. Siphonal canal moderately wide and parallel-sided.

Type species. — *Vanpalmeria africana* Adegoke, new species.

Name. — The new genus and family is named in honor of Dr. (Mrs.) Katherine Van Winkle Palmer of the Paleontological Research Institution, Ithaca, New York, U.S.A.

The tendency for apical extensions of the callus to cover spire whorls either partially or almost completely is not uncommon among gastropods (for example, *Terebellum* and *Seraphs* among the Strombidae, *Ancilla (Sparella)*, *Ancilla (Ancillus)* and *Agaronia* among the Olividae (Jung and Abbott, 1967; Eames, 1952). In none of these families is the calcareous cover as heavy and composed of as many distinct, variably oriented, feltlike layers as in the specimens here assigned to this new family. The new family is further characterized by the development of a long, narrow columella which bears three plications. Such plications are unknown in the other groups in which the spire is partially covered by the callus.

For these reasons, it has been considered necessary to assign this taxon to a distinct family within the superfamily Volutacea.

Vanpalmeria africana Adegoke, new species Pl. 31, figs. 7-10

Description. — Same as for genus.

Material. — The two type specimens only.

Types. — Holotype, UIMG No. 388; paratype, USNM No. 174882.

Dimensions (mm). —

	height	maximum diameter
UIMG 388	10.36	3.65
USNM 174882	6.55	2.70

Remarks. — The diagnostic characteristics of the present species are the heavy, many-layered calcareous deposit completely covering the spire and body whorl, the glossy, streamlined exterior and the presence of three plications on the elongate columella. Because of paucity of material (only two specimens were collected), no details can be given here on the mode of accretion of the heavy calcareous cover. Partially dissected specimens show that there are several layers which vary considerably in thickness. The innermost layers fill up the irregularities in the whorl profile. The shell is thus fairly thick at the sutures. Other uniformly thick layers are merely added on this streamlined base.

The calcite is made up of thin, feltlike units whose orientation vary from layer to layer. Two predominant directions were observed, one slightly oblique to the longitudinal axis and the other slightly oblique to the spiral axis. Both the interior and exterior surfaces of the shell have fibers oblique to the longitudinal axis of the shell and both layers are smoothly glazed in marked contrast to the amorphous texture of the intervening layers.

Greater details of the wall structure as well as the affinity of *Vanpalmeria* must await the collection and detailed petrographic examination of additional specimens.

Family **CANCELLARIIDAE** Gray, 1853
Genus **BONELLITIA** Jousseaume, 1887
Subgenus **ADMETULA** Cossmann, 1889

Bonellitia (Admetula) imevborei Adegoke, new species Pl. 31, figs. 16-19

Description. — Shell small, spire moderately high, consisting of only three large and high whorls. Protoconch bulbous and smooth. Spire whorls with convex sides and sinuous, moderately channelled suture.

Body whorl high, constituting about 3/5 height of shell, rhomboid-quadrate in profile. Sculpture consists of weakly developed axial and spiral ribs. Axial ribs moderately wide and rounded, separated by narrower interspaces. Two axial ribs are more prominently elevated to form varices, the anterior beginning on the parietal surface near the junction of the inner and outer lip margins, the second, which is more strongly oblique, begins near the anterior tip of the columella and swings gently to the left as it ascends the last spire whorl. A prominent varix also borders the exterior margin of the outer lip.

Spiral sculpture consists of three narrow distant spiral ribs on the spire whorls and about seven spirals on the body whorl. These form a reticulate pattern with the weak axial ribs. Interspaces bear weak threads.

Columella short and stout, with well-developed callus and siphonal fasciole. Bears two prominent plications interiorly and a rudimentary third plication anteriorly. Outer lip margin thick, inner border bears about six or seven sub-prominent denticulations. Siphonal canal short, emarginate. Aperture narrow, elongate, and slightly curved, only slightly wider than siphonal canal.

Material. — Two well-preserved specimens.

Types. — Holotype, UIMG No. 389; paratype, USNM No. 174883.

Dimensions (mm). —

	height	maximum diameter
UIMG 389	6.26	2.78
USNM 174883	3.95	1.95

Remarks. — This elegant species is represented by two complete tiny specimens. Their characteristic features include the relatively high spire, the large spire whorls, the wavy suture, the reticulate sculpture, the varices, and the presence of two prominent columellar plications.

Their spires are relatively higher, and their columellar plications fewer than those of most European and African species referred to *Bonellitia.* Most of the latter have three columellar plications. They are retained within the genus because of their close similarity in spire height and sculpture with the American Eocene species of *Bonellitia* discussed and figured by Palmer (1937). She further indicated that species of the genus may have two or three columellar plications.

The new species may be readily distinguished from *Bonellitia (Admetula) amekiensis* (Eames, 1957; Adegoke, 1969b, pl. 1, fig. 10) from the Ameki Formation (Eocene) of eastern Nigeria by its smaller, more slender shell, the more robust and higher spire whorls, the weaker axial sculpture, and the presence of two as against three columellar plications.

Eames' (*op. cit.*, p. 49) suggestion that the subgeneric category *Admetula* be retained for forms with less muricate sculpture is accepted here. This weak axial sculpturing distinguishes the African Tertiary species from most of the American forms (Palmer 1937).

The new species is named in honor of my friend, Professor A. M. A. Imevbore, Department of Biological Sciences, University of Ife, Nigeria.

Subgenus **AFRICOSTOMA** Eames, 1957

Bonellitia (Africostoma) sp. indet. Pl. 31, fig. 20

Material. — A single poorly preserved specimen.

Dimensions. — Height 4.00 mm; maximum diameter 2.60 mm.

Illustrated specimen. — UIMG No. 390.

Remarks. — A single, poorly preserved internal cast of a *Trigonostoma*-like species was collected at Ewekoro. The spire is small and is made up of only a few whorls. The body whorl is large, constituting more than ¾ height of the shell, bears a high shoulder shelf, and a detached outer lip enclosing an arcuate aperture. No trace of exterior sculpture is preserved.

The characters of this specimen closely conform to those of Eames' subgenus *Africostoma* (Eames, 1957, p. 49, pl. 7, figs. 6a-c). The Ewekoro specimen is assigned to that subgenus.

Family **RISSOIDAE** H. and A. Adams, 1854

Genus **KEILOSTOMA** Deshayes, 1848

Keilostoma septemzonatum Cox Pl. 31, figs. 23-26

Keilostoma septemzonatum Cox, 1952, p. 49, pl. 5, figs. 8, 9.

Material. — About 14 adult and juvenile specimens.

Types. — Hypotypes, UIMG Nos. 391, 392, USNM Nos. 174884, 174885, PRI No. 29811.

Dimensions (mm). —

	height	maximum diameter
UIMG 391	7.45	3.35
UIMG 392	14.65	5.55
USNM 174884	3.65	1.85
USNM 174885	3.55	2.20

Remarks. — This species is represented by over a dozen specimens ranging from young to mature forms. The presence of a heavy callosity on the exterior of the outer lip confirms Cox's (1952) generic assignment. As pointed out by Cox (1952, p. 49) it closely resembles the Paris Basin species, *Paryphostoma minus* Deshayes (Cossmann and Pissarro, 1910-1913; Furon and Soyer, 1947). The latter has more spirals ribs on the whorls.

The species differs also from the Senegalese specimens referred to *Paryphostoma* cf. *minus* Deshayes by Chabaglian (1959, p. 156, pl. 3, figs. 8-9; text-figs. 9a, b) by its smaller size, the more convex earlier whorls, and the fewer spirals on the adult body whorl. There are 14 spirals on the body whorl of the Senegalese specimens.

Superfamily **TONNACEA** Suter, 1913

Family **CASSIDIDAE** Herrmannsen, 1845

Genus **ONISCIDIA** Swainson, 1840

?**Oniscidia** sp. aff. **O. chavani** (Furon) Pl. 31, figs. 21, 22

Material. — Two imperfectly preserved specimens.

Types. — Hypotypes, UIMG No. 393, USNM No. 174886.

Dimensions (mm).—

	height	maximum diameter
UIMG 393	4.6	2.9
USNM 174886	4.0+	2.8

Remarks.—This species is represented by two worn specimens. They resemble *O. chavani* recorded to date from the Paleocene of Togo and Senegal (Furon, 1948, p. 107, pl. 9, fig. 8; Chabaglian, 1959, p. 152, pl. 2, figs. 3, 4) in general outline and the possession of about 20 axial ribs. The Togolese and Senegalese material differ, by the deep, uniformly wide interspaces and the elevation of the upper margin of the outer lip rendering the body whorl more quadrate than in the Ewekoro specimens. It is assumed here that these differences were probably a result of erosion of the Nigerian specimens. Should more completely preserved material prove this assumption wrong, the Nigerian material should be described as a new species.

The whorl profile is also reminiscent of that of *Pseudoliva funkeana* Adegoke, new species. The axial sculpture and the absence of an anterior spiral groove precludes assignment of this species to *Pseudoliva.*

Family **BURSIDAE**
(Ranellidae)

Genus **BURSA** ("Bolten") Röding, 1798

Bursa saundersi Adegoke, new species Pl. 31, figs. 27, 28

?*Triton* sp. Chabaglian, 1959, p. 158, pl. 2, figs. 1, 2.

Description.—Shell small, consisting of a short spire of about five convex but low whorls and a high body whorl constituting more than ⅔ height of shell. Shell flattened dorso-ventrally, with two flat and heavy varices on the body whorl and the last three spire whorls. Protoconch unknown, earliest preserved nuclear whorl without varices. Varices located about 180° apart and are not in line from whorl to whorl.

Earliest preserved whorl sculptured by three spirals of which the middle is heaviest. Later whorls bear five spirals. The three adapical ones above the angulation are weakly developed while the two anterior ones are heavy, producing a slight angulation of the whorls.

Several fine secondary and tertiary threads occur in the interspaces. Axial sculpture consists of regularly spaced, weak ridges, five between the varices dorsally and six ventrally; they produce laterally elongate coarse nodes at the intersection with the spiral ribs giving the whorls a reticulate sculpture.

Columella straight and stout, ornamented by closely spaced, slightly oblique spirals between which are three fine threads. Outer lip margin not preserved.

Material. — The holotype only.

Type. — Holotype, UIMG No. 394.

Dimensions. — Height 22.00 mm; maximum diameter 14.40 mm.

Remarks. — This species is based on a single well-preserved specimen. It closely resembles and may be conspecific with the Senegal specimen described and figured as *Triton* sp. by Chabaglian (1959, p. 158, pl. 2, figs. 1, 2).

It differs from *Bursa chira chira* Olsson (1929) from the Peruvian Oligocene in the details of sculpture. The Peruvian species virtually lacks axial ornamentation.

The new species is probably ancestral to the high-spired genus *Varicohilda* Eames (1957) from the Eocene of eastern Nigeria.

The new species is named in honor of Mr. C. L. Saunders, Works Manager, West African Portland Cement Co., Ewekoro, Nigeria.

Family **CYMATIIDAE** Iredale, 1913

Genus **SASSIA** Bellardi, 1872

Sassia nigeriana Adegoke, new species Pl. 32, figs. 1-5

Description. — Shell small, with short spire of about two-three large, convex whorls, each about twice as wide as high. Early spire whorls smooth, later whorls bear three heavy spiral ribs.

Body whorl high, constituting about ⅔ height of shell, slightly wider than last spire whorl, bears a reticulate sculpture consisting of heavy, gently curved axial ridges intersected by six regularly spaced, narrow spiral ribs, the adapical of which is located just below the suture. About seven spirals adorn the lower body whorl. Three discontinuous varices present on the penultimate and body whorls of adult specimens. Columella distinctly constricted from body, tapering abruptly anteriorly. Aperture wide, subquadrate, opens anteriorly into the short, moderately wide, parallel-sided siphonal canal. Outer lip margin not preserved.

Material. — Five nearly complete but mostly immature specimens.

Types. — Holotype, USNM No. 174742; paratypes, UIMG Nos. 395-397.

Dimensions (mm). —

	height	maximum diameter
UIMG 395	—	1.62
UIMG 396	1.90	1.55
UIMG 397	2.42	2.20
USNM 174742	2.65	1.90

Remarks. — This species is characterized by its large, convex spiral whorls which are almost as wide as the body whorl, the reticulate sculpture and the ontogenetically late and discontinuous development of varices.

Of the five specimens here referred to the species, only one adult shows complete development of the three varices. The penultimate whorl of the specimen also shows three worn spiral ribs thus confirming closely in that feature to the English Eocene species of *Sassia* described by Wrigley (1932). The English forms are higher-spired than the present species.

The Nigerian species most closely resembles *Sassia faxense* (Ravn, 1902) from the Danian Calcaire de Faxe (Ravn, 1933, p. 58, pl. 5, figs. 16a, b; pl. 6, figs. 7a, b). The latter also shows an ontogenetic late development of the varices as in the Nigerian species. They are different in that the whorls are more spinose and the axial ribs narrower.

The fatter spiral whorls and the wider axial ribs distinguish *S. nigeriana* Adegoke, new species, from *S. rutoti* Vincent (1930b) from the Montian of Poudingue.

Sassia africana Adegoke, new species Pl. 32, figs. 6-11

Description. — Shell minute, high-spired, consisting of about six-seven whorls. Spire whorls increase rapidly in diameter as added.

Protoconch and earliest two-three nuclear whorls smooth, later whorls bear subdued axial and prominent spiral ribs. About eight straight to slightly oblique axial ribs present on adult body whorl, crossed on the penultimate whorl by five spiral ribs separated by interspaces of approximately the same width as the ribs. About eight spiral ribs with wider interspaces bearing intercalary threads present on the body whorl.

Columella bent, tapers only slightly. Aperture quadrate. Siphonal canal short, moderately narrow.

Material. — Three specimens.

Types. — Holotype, UIMG No. 398; paratypes, UIMG No. 399, USNM No. 174887.

Dimensions (mm). —

	height	maximum diameter
UIMG 398	2.85	1.85
UIMG 399	2.10	1.35
USNM 174887	1.90	1.10

Remarks. — This species is based on three incomplete specimens. It differs from *Sassia nigeriana* Adegoke, new species by its slightly higher, more slender shell, the much higher spire, the less inflated whorls, and the less prominent axial sculpture.

Order NEOGASTROPODA Thiele, 1925
(=Caenogastropoda Cox, 1959)

Superfamily **MURICACEA** Rafinesque, 1815
Family **MURICIDAE** Rafinesque, 1815
Subfamily **RAPANINAE**
Genus **RAPANA** Schumacher, 1817
Subgenus **NIGERAPANA** Adegoke, new subgenus

Diagnosis. — Shell medium-sized, spire moderately elevated, whorls increasing gradually in diameter as added, ornamented by a moderately raised circle of nodes which are prominently developed only in the abapical third of the whorl but suppressed in the adapical portion. The position of nodes alternate from whorl to whorl.

Body whorl large, conspicuously constricted anteriorly, bears a circlet of eight partially hollow nodes. Whorls ornamented by numerous, straight, and fine growth lamellae, which are folded sharply over the spines producing a partially hollow interior. Growth line trace straight to slightly oblique above the spines, gently curved below. Columella heavy, straight, and cylindrical, with a deep pseudumbilicus anteriorly and a heavy callus coat. Aperture trigonal. Siphonal canal apparently narrow.

Type species.—*Rapana (Nigerapana) ewekoroensis* Adegoke, new species.

Remarks.—Within the genus *Rapana,* the closest affinity of the new subgenus is with *Forreria* Jousseaume, 1880, known from the Miocene to Recent of western North America (Loel and Corey, 1932, p. 244, pls. 50-55; Wenz, 1938-44, p. 1084; Adegoke, 1969a, pl. 11, figs. 1, 5). They differ by the more uniform taper of the spire of the new subgenus, its smaller size, the quadrate aperture, the heavier development of columellar callosity, the straighter and more conspicuous growth lamellae, and the deeper pseudumbilicus.

Rapana (Nigerapana) ewekoroensis Adegoke, new species Pl. 32, figs. 12-14

Description.—Shell medium-sized, with a moderately high spire of five-six whorls which increase gradually in diameter as added. Spire whorls ornamented by axial nodes which are prominently elevated only in the lower third of the whorl. Nodes alternate in position from whorl to whorl. Suture wavy around bases of nodes, incised.

Body whorl large, constituting more than two-thirds height of shell. Ornamented by about eight axial nodes and several coarse spirals of which the posterior three are very coarse, subequal and distantly placed; a series of finer, closer-spaced spirals adorn the anterior portion. Columella heavy, cylindrical, covered by a thick callus which extends over the parietal surface; a deep pseudumbilicus located anteriorly.

Aperture trigonal with apex coinciding with position of row of spines.

Material.—The new species is based on the holotype only.

Type.—Holotype, UIMG No. 400.

Dimensions (mm).—Height 39.68 mm; maximum diameter 31.10 mm.

Remarks.—This new species is characterized by its heavy columella and columellar callus, the deep pseudumbilicus, and the straight growth lamellae.

Subfamily **MURICINAE** Cossmann, 1903
Genus **HEXAPLEX** Perry, 1811
Subgenus **PAZIELLA** Jousseaume, 1880

Hexaplex (Paziella) ewekoroensis Adegoke, new species Pl. 32, figs. 15-21

Description. — Shell small, fusiform, with a high spire consisting of a series of five-six smooth post-nuclear whorls and an axially sculptured final spire whorl. Early whorls gently convex. Penultimate and body whorls angulated adapically, bearing on the average, seven prominently elevated, muricate axial ridges which are curved at their adapical ends. Specimens with eight or nine varices common. Adapical ends of first row to axial ribs cross the adapical suture and are attached to the base of the preceding whorl (Pl. 32, figs. 17, 19, 21).

Body whorl high, constituting more than half height of the shell; sharply angulated adapically and bearing between seven and nine prominently elevated axial ribs, and ornamented by three inconspicuous spiral ribs below the adapical angle.

Columella stout, slightly deflected; siphonal fasciole poorly developed. Outer lip thick, with a varix near the margin, bearing two small denticles laterally, below which is a spiral ridge that runs toward the siphonal canal. Aperture trigonal, opens into a relatively wide siphonal canal.

Material. — Eight well-preserved specimens.

Types. — Holotype, UIMG No. 401; paratypes, UIMG Nos. 402, 403, USNM 174888, 174889.

Dimensions (mm). —

	height	maximum diameter
UIMG 401	5.40	3.00
UIMG 402	4.30	2.50
UIMG 403	3.10	1.70
USNM 174888	2.50	1.25
USNM 174889	2.90	1.65

Remarks. — The subgeneric assignment of this species of *Hexaplex* to *Paziella* is based on the possession of an average of seven axial folds supported also by the minute size. The occurrence in the population of specimens with up to nine varices suggests that the subgeneric differentiation between *Paziella* and *Poirieria* based on meristic count of varices alone (Eames, 1957; Wenz, 1938-1944, p. 1090) is invalid.

The present species differs from species of other subgenera of *Hexaplex* by its unusually high number of smooth nuclear whorls, the acute apex, the virtual absence of spiral sculpture, and the fact that only the last two whorls bear axial sculpture.

Hexaplex (Paziella) ewekoroensis Adegoke is smaller than *H. (P.) bendeica* Eames from the Eocene Ameki Formation of eastern Nigeria (Newton, 1922, p. 31, pl. 3, figs. 22-23; Eames, 1957, p. 41; Adegoke, 1969b, pl. 1, fig. 14). It differs by its higher, less ornate spire, the fewer labral denticles, and the less strongly developed spiral sculpture.

The new species is considered as the probable ancestral form which gave rise to *H. (P.) bendeica* in the Eocene through the development of stronger spiral sculpture (and associated labral denticles, the fewer nuclear whorls and deeper lateral notch.

The new species is smaller, more muricate, less spirally sculptured, and with fewer labral denticulations than *Murex (Poirieria) disparata* Vincent (1930a) from the Paleocene of Limbourg.

The species most closely resembles in final adult size and sculpture the Copenhagen Paleocene species described as *Murex nanus* by Ravn (1939, p. 78, pl. 3, figs. 7a, b). Both have varices only on the final and penultimate whorls. The new species may be distinguished by its higher spire, the narrower aperture, and the fewer spiral sculpture.

Superfamily **ACTEONACEA** d'Orbigny, 1842
Family **ACTEONIDAE** d'Orbigny, 1842
Genus **TORNATELLAEA** Conrad, 1860
Subgenus **RAVNIELLA** Rosenkrantz, 1970

Tornatellaea (Ravniella) africana Furon Pl. 32, figs. 22-26

Tornatellaea africana Furon, 1948, p. 111, pl. 9, fig. 20; Chabaglian, 1959, p. 153, pl. 3, fig. 5, text-fig. 8.
Tornatellaea (Ravniella) africana Furon, Adegoke, 1972b, pl. 1, fig. 8.; 1973, fig. 5.

Description. — Shell small, with a short spire of about six whorls and a much larger body whorl constituting more than ¾ height of the shell. Shell ornamented by several moderately wide, flat-topped spirals, separated by slightly wider interspaces. Six spiral ribs present on most spire whorls and about 20 on the body whorl. Narrow axial threads cross the interspaces. Columella has two strongly elevated plications and a well-developed parietal fold, separated by a wide spiral groove. A well-developed, finely sculptured siphonal fasciole, and pseudumbilicus present.

Material. — Six specimens.

Types. — Hypotypes, UIMG Nos. 404-406, USNM 174745.

Dimensions (mm). —

	height	maximum diameter
UIMG 404	4.95	3.40
UIMG 405	5.35	3.45
UIMG 406	3.62	1.86
USNM 174745	7.10	3.85

Remarks. — The morphologic features of the Ewekoro material agrees closely with those of the type. Furon's claim that 15 spirals were present on the body whorl is probably an error especially because the Nigerian, as well as the Senegalese specimens (Chabaglian, 1959) have, on the average, 20 spirals.

Tornatellaea (R.) africana Furon differs from the European Paleocene species *T. (R.) selandica* (Ravn) by its smaller, shorter spire, the less robust body whorl, and the more oblique columellar plications.

The affinities and stratigraphic range of the subgenus *Ravniella* were discussed by Rosenkrantz (1970, p. 433) who showed that the subgenus has so far been recorded only from the lower Paleocene. This and that all West African records of *Tornatellaea (R.) africana* to date are from Paleocene strata (Furon, 1948; Chabaglian, 1959) confirm my contention (Adegoke, 1972b, 1973) that the species is an index to the Paleocene in West Africa.

Family **SCAPHANDRIDAE**

Genus **CYLICHNA** Loven, 1846

Cylichna makanjuolai Adegoke, new speeies Pl. 32, figs. 27-34

Description. — Shell small to medium-sized, cylindrical. Spire completely involute, truncated, with a deep apical perforation.

Body whorl uniformly cylindrical, widest portion about midway.

Columella slightly twisted, with a shallow adapical notch. Inner lip demarcated from parietal surface by a spiral groove. Parietal surface covered by a thin callus. Aperture narrow, with parallel sides, slightly dilated anteriorly. Adapical edge of the outer lips elevated above spire.

Shell ornamented by faint growth marks and several fine spiral threads which are most conspicuous near the anterior end and less so near the apical end of the shell, the middle portion being virtually smooth.

Material. — Over 60 well-preserved specimens.

Types. — Holotype, UIMG No. 407; paratypes, UIMG Nos. 408, 409, USNM Nos. 174890-174892, PRI Nos. 29812-29814.

Dimensions (mm). —

	height	maximum diameter
UIMG 407	4.20	1.70
UIMG 408	3.35	1.50
UIMG 409	2.80	1.20
USNM 174890	2.90	1.25
USNM 174891	3.95	1.55
USNM 174892	3.55	1.35

Remarks. — The characters of this species closely resemble those of species of *Scaphander* Montfort especially the external ornamentation, the development of a callus on the parietal wall (Grant and Gale, 1935, p. 451; Palmer *in* Richards and Palmer, 1953), and the lack of a columellar fold. It is here retained in *Cylichna* because of the weak spiral sculpture and the open apical perforation. Many of the worn shells show no ornamentation at all.

The new species closely resembles the inadequately described and illustrated species *Bullinella (Cylichnina) togoensis* Furon (1948, p. 111, pl. 9, fig. 22) but differs by its more cylindrical outline, the truncated posterior end, the elevated adapical margin of the outer lip, the distinct inner lip notch and spiral groove, the wider anterior edge of the aperture, and the presence of spiral ornamentation.

The new species also resembles *C. discifera* von Koenen from the Paleocene of Copenhagen but differs by the inconspicuous development of axial sculpture and its wider terminal ends.

The new species also resembles *C. montensis* (=*Roxania montensis* Vincent, 1930b, p. 56, text-fig. 37, pl. 3, fig. 4). The latter has adapical and abapical spiral sculpture and is smooth medianly. *C. makanjuolai* Adegoke, new species is different in having a more quadrate shell, finer sculpture, and a narrower anterior edge of the outer lip.

The new species is named in honor of Dr. A. A. Makanjuola of the Department of Geology, University of Ibadan, Nigeria.

Class BIVALVIA Linnaeus, 1758

Subclass PTERIOMORPHIA Beurlen, 1944

Order ARCOIDA Stoliczka, 1871

Superfamily **ARCACEA** Lamarck, 1809
Family **ARCIDAE** Lamarck, 1809
Subfamily **ARCINAE** Lamarck, 1809
Genus **ARCA** Linnaeus, 1758
Subgenus **ARCA** s.s.

Arca (Arca) accra Cox Pl. 33, figs. 1-3

Arca accra Cox, 1952, p. 36, pl. 4, fig. 4.
?*Arca* sp. Chabaglian, 1959, p. 163, pl. 3, fig. 14.

Material. — Two specimens.

Type. — Hypotypes UIMG No. 414, USNM No. 174895.

Dimensions (mm). —

	length	height
UIMG 414	23.30	12.95
USNM 174895	5.25	2.95

Remarks. — Though the larger of the two well-preserved specimens of this species collected from the Ewekoro quarry is almost twice as large as Cox's (1952) holotype, it shows identical morphologic features. The species is characterized by the irregularity of the nodes formed at the intersection of the concentric and radial ribs and the development of three prominent and one minor ribs on the flattened postero-dorsal margin. As stressed by Cox (*op. cit.*), the nature of the ligamental area and dentition show that the species belongs to *Arca s. s.* (Reinhart, 1935, 1943; Cox and others, 1969).

The Nigerian specimens closely resemble the specimen from the Paleocene Fallock quarry of Senegal (Chabaglian, 1959). Both have closely comparable sculpture (though slightly finer in the Senegal specimen) with the holotype.

The species is comparable with *Arca (Arca) diourbelensis* Freneix and Gorodiski (1963) from the Paleocene of Senegal. The Senegalese species is smaller, less elongate but with a more prominent umbonal ridge and finer sculpture than the present species.

Genus **BARBATIA** Gray, 1842

Subgenus **BARBATIA** s.s.

Barbatia (Barbatia) nigeriensis Adegoke, new species Pl. 33, figs. 4-6

Description. — Shell medium-sized, inequilateral. Beak blunt, strongly prosogyrate. Umbo oblique, compressed. Anterior dorsal margin short, concave, merging at an obtuse angle with the high, broadly rounded antero-ventral margin. Posterior dorsal margin elongate, gently convex slopes from beak at an angle of about 30° and merges gradually with the protracted postero-ventral margin. Ventral margin gently rounded. Cardinal area narrow, incompletely preserved; bears anteriorly a few, trigonal, strongly convergent teeth.

Sculpture consists of numerous, narrow radial ribs separated by narrow interspaces which widen toward the ventral margin where they are almost as wide as the ribs. These ribs bifurcate at varying distances along their length with the interspaces between the bifurcated limbs widening rapidly and rivalling the primary interspaces in width near the ventral margin. Radial ribs are crossed by narrow, distant concentric grooves on the umbonal half of the shell and by equidistant ribs, subequal in diameter to the radial ribs in the ventral half.

Material. — The new species is based on the type material only.

Types. — Holotype, UIMG No. 415; paratype, USNM No. 174896.

Dimensions (mm). —

	length	height
UIMG 415	23.60	16.35
USNM 174896	14.40+	12.30

Remarks. — This elegant species is represented by two specimens, a right and a left valve. The hinge structure is only partly preserved on the smaller left valve (Pl. 33, fig. 6).

The cardinal area and the few convergent teeth of the new species are reminiscent of those of *Barbatia rigaulti* (Deshayes) from the Bartonian of the Paris Basin (Cossmann and Pissarro, 1904-1906, pl. 36, fig. 110-37).

Barbatia (Barbatia) ewekoroensis Adegoke, new species Pl. 33, fig. 7

Description. — Shell small, trapezoidal. Beak small, strongly prosogyrate. Umbo compressed; a prominent umbonal-ventral groove divides shell into two lobes. Anterior cardinal margin short, about one-third length of cardinal area. Anterior dorsal margin short, perpendicular to the umbonal-ventral axis, merges almost at right angles with the anterior margin. Posterior margin elongate with a weakly developed posterior umbonal ridge which extends broadly to the posterior lobe.

Hinge line straight and narrow, bears few, blunt, convergent teeth. About five or six teeth present anterior to the beak. Posterior teeth less well preserved but probably not exceeding 10 or 11 in number. Shell sculptured by coarse, prominently elevated concentric ribs separated by interspaces half again as wide as the ribs. Radial sculpture not observed.

Material. — The holotype only.

Type. — Holotype, UIMG No. 416.

Dimensions. — Length 9.90 mm; height 6.60 mm.

Remarks. — This species is characterized by its small size, the elongate, lobelike extension of the posterior ventral margin and the sculpture consisting of coarse, distant, concentric ribs only.

It resembles, the Moroccan Eocene species *Barbatia mongini* Salvan (1954, p. 10, text-fig. 4, pl. 1, figs. 11-13) by its reduced ligamental area and sculpture but differs by its straighter hinge line, the possession of fewer, blunter teeth, and the less prominent anal depression.

Barbatia (Barbatia) yoloyei Adegoke, new species Pl. 33, fig. 8

Description. — Shell minute, ovoid, and strongly convex. Beak moderately developed, located anterior of the midline, prosogyrate, umbonal-ventral ridge subdued. Hinge margin straight, bears three blunt, distantly-spaced teeth on either side of the excavated center of the hinge plate. Excavated central area devoid of teeth. Interior margin of shell finely crenulate. Exterior ornamented by several moderately wide, prominently raised, equidistant concentric ribs, separated by interspaces slightly wider than the ribs. Radial sculpture lacking.

Material. — The holotype only.

Type. — Holotype, UIMG No. 417.

Dimensions. — Length 1.2 mm; height 1.0 mm.

Remarks. — This minute species is characterized by its oval outline, the few, distant teeth on the excavated hinge plate, the inequilateral hinge area, and the concentric sculpture lacking radial elements. These features distinguish it from most described lower Tertiary species of *Barbatia.*

The new species is named in honor of my friend Dr. V. L. A. Yoloye, School of Biology, University of Lagos, Nigeria.

Subgenus **ACAR** Gray, 1857

Barbatia (Acar) micronodosa Adegoke, new species Pl. 33, figs. 9-11

Description. — Shell small, compact, strongly quadrate. Beak moderately narrow, slightly prosogyrate. Umbo depressed medianly by a furrow which becomes wider and more prominent toward the ventral margin.

Anterior dorsal margin short, about half the length of the posterior dorsal margin, makes a conspicuous obtuse angle where it merges with the broadly rounded anterior margin. Posterior umbonal carina prominent, extending to the protracted postero-ventral margin of shell. Ventral margin concave.

Shell ornamented by a series of widely spaced concentric ribs which are prominently modified into small rounded nodes where they are intersected by the close-spaced, fine radial ribs. Subprominent concentric growth lamellae present between the concentric nodes. Radial ribs and hence concentric nodes are wider spaced and coarser on the posterior flange. Hinge area straight and moderately long, narrow. Internal features unknown.

Material. — The species is based on a single articulated specimen.

Type. — Holotype, UIMG No. 418.

Dimensions. — Length 11.30 mm; height 6.75 mm; thickness of both valves 5.65 mm.

Remarks. — This elegant species is characterized by its highly inflated, bi-lobed shell, the strongly developed posterior umbonal carina, and the fine concentric nodes — a feature for which it is named.

Though its internal features are unknown, the compact, quadrate shell, with the posterior umbonal carina and the structure of the ligamental area all confirm placement within the subgenus *Acar* (Bartsch, 1931; Reinhart, 1935, 1939, 1943; Cox and others, 1969).

The new species may be readily distinguished from *Barbatia (Acar) putealis* Cox recorded originally from Ghana but found also at Ewekoro by its slightly larger, less quadrate shell. The posterior umbonal carina is slightly more prominent and oblique and extends farther down the postero-ventral margin producing a posterior lobe-like extension of the shell. The concentric ribs are more distantly spaced and are more finely noded.

The shape and sculpture of the new species are reminiscent of those of the type species (Reinhart, 1939, pl. 3, fig. 1). Its anterior margin is less elongate, the sculpture much finer with less prominently raised radial ribs.

Family **PARALLELODONTIDAE** Dall, 1898

Subfamily **GRAMMATODONTINAE** Branson, 1942

Genus **CUCULLARIA** Conrad, 1869

Cucullaria coxi Adegoke, new species Pl. 33, figs. 13, 14

Description. — Shell small, strongly inequilateral, oblong-trapeziform. Umbo small, depressed dorsally; beak small, prosogyrate, ligamental area small. Anterior dorsal margin short, less than one-fifth length of shell, broadly rounded. Posterior dorsal margin elongate, convex, merging smoothly into the broadly rounded posterior margin. Posterior umbonal ridge prominent, runs obliquely toward the postero-ventral margin. Anal fold, shallow and broad, visible near ventral margin.

Hinge line straight, cardinal area narrow, bears two teeth parallel to the hinge margin (posterior margin broken during preparation) which are visible only at both ends. Teeth in the intermediate areas obsolete and probably lacking.

Shell sculptured by several, distant, unevenly developed and broad concentric ridges, crossed on the umbonal region only by the less prominent radial threads. Radial sculpture absent on the rest of shell. Shell surface with a glossy finish.

Material. — The holotype only.

Type. — Holotype, UIMG No. 420.

Dimensions. — Length 15.85 mm; height 8.65 mm.

Remarks. — This species is represented by a single well-preserved specimen. Its morphological characters (especially shape, cardinal area, and teeth) are so closely comparable with those of *Cucullaria africana* Cox that both are here considered closely related. They differ only in the nature of the external sculpture. *C. africana* Cox is reticulately sculptured especially in the posterior portion whereas radial sculpture is feebly developed only on the umbo of the new species.

The new species is named in honor of the late Dr. L. R. Cox.

Family **CUCULLAEIDAE** Stewart, 1930

Genus **CUCULLAEA** Lamarck, 1801

Cucullaea ewekoroensis Adegoke, new species Pl. 33, figs. 19, 20

Description. — Shell medium-sized, subrhomboidal, strongly inequilateral. Beak small, prosogyrate. Umbo flattened with an oblique umbonal ridge running to the postero-ventral margin. Anterior region short. Posterior-dorsal margin elongate, constituting more than 4/5 length of shell. Umbonal-ventral ridge broad and prominently elevated.

Cardinal area broad, gently inclined, with three heavy, broad, and divergent chevron-shaped ligamental ridges. Marginal teeth poorly preserved.

Shell sculptured reticulately by moderately broad concentric ribs separated by narrow, shallow, grooves and numerous radial ribs, which are coarse and uneven in width in the anterior portion of the shell, separated by interspaces about half as wide as the ribs. In the posterior portion, the radial ribs become finer, are uneven and separated by narrow grooves. Rounded nodes are formed at the intersection of concentric and radial ribs.

Material. — One left valve.

Type. — Holotype, UIMG No. 421.

Dimensions. — Length 41.7 mm; height 33.0 mm.

Remarks. — This species is characterized by its strongly inequilateral shape, the high cardinal area, the heavy, broad, divergent chevron-shaped ligamental ridges and grooves and the reticulate sculpture. In these features, it closely resembles the Cannonball

Paleocene species, *Cucullaea solenensis* Stanton (1920; Cvancara, 1966, p. 304, pl. 2, figs. 1-6, 9-13). They differ in that the Nigerian species is more elongate posteriorly, with a more prominent anal depression; the shell is much more flattened and the sculpture is weaker. As pointed out by Nicol (1950c, 1954) divergent ligamental grooves are present on fossil but not on living *Cucullaea* (Habe, 1964).

Cucullaea ewekoroensis new species, is flatter, with a greater length to height ratio and a more prominent anal depression than the American Midwayan species figured by Harris (1896, pls. 3, 4) and Gardner (1933, pl. 7). Its posterior elongation is comparable to that of *C. kaufmanensis* Gardner.

The new species superficially resembles *Cucullaria africana* Cox (1952, p. 37, pl. 4, figs. 7a, b) and *Cucullaria congica* Vincent (1913, p. 25, pl. 2, figs. 16, 17) especially by its obliquely elongate postero-ventral margin and the reticulate sculpture. It differs by its higher cardinal area and the heavier ligamental chevrons.

Superfamily **LIMOPSACEA** Dall, 1895

Family **GLYCYMERIDIDAE** Newton, 1922

Subfamily **GLYCYMERIDINAE** Newton, 1922

Genus **GLYCYMERIS** da Costa, 1778

Glycymeris (Glycymeris) togoensis (Oppenheim) Pl. 33, figs. 15-18

Pectunculus togoensis Oppenheim, 1915, p. 21, pl. 1, figs. 14a, b; Furon, 1948, p. 101.

Material. — Over 65 complete specimens.

Types. — Hypotypes, UIMG No. 422, USNM No. 174897, PRI Nos. 29825, 29770.

Dimensions (mm). —

	length	height
UIMG 422	10.70	8.80
USNM 174897	10.50	8.90

Remarks. — This is the most abundant species of *Glycymeris* in the Ewekoro fauna. It is represented by over 65 complete specimens ranging in size from immature individuals about 1 mm long and high to adults measuring almost 12 mm in length.

The species is characterized by its oval-quadrate outline, the strongly convex shell with broad axial ribs separated by linear grooves and the gently arched hinge line with a variable number of strongly convergent teeth (Oppenheim, 1915, *op. cit.*). On immature specimens, as few as four or five teeth occur on either side of the small, orthogyrate beak. The number increases in adults to an average of about eight on either side of the beak. On one specimen as many as 10 teeth were counted. Teeth are suppressed in the middle of the hinge line below the beak. Here three relatively small teeth are present, the outer two of which are convergent. The latter feature serves to distinguish the species from the concurrent *Glycymeris subtogoensis* (Furon) which has six small teeth in the median region.

On complete specimens, the interior ventral margin shows strong denticulations. Thus, as pointed out by Furon (1948, p. 101), Oppenheim's description and figured specimens are not adequately diagnostic.

Considerable variation was also observed in the texture of the exterior sculpture. In most specimens, the radial ribs are of the coarse type with narrow interspaces as illustrated by Oppenheim. On a large number of specimens the ribs are much finer, bifurcating, and closely packed. It is assumed that this is as variable a feature in this genus as has been claimed for the Arcidae (Reinhart, 1939).

Glycymeris (Glycymeris) subtogoensis? (Furon) Pl. 34, figs. 1, 2

Pectunculus subtogoensis Furon, 1948, p. 101, pl. 8, fig. 12.
Glycymeris (Pectunculus) subtogoensis Furon, Tessier, 1952, p. 318, pl. 19, figs. 2, 3.
Glycymeris togoensis Furon, Chabaglian, 1959, pp. 140, 141, 142, 143, 146.

Material. — One specimen.

Type. — Hypotype, UIMG No. 423.

Dimensions. — Length 4.15 mm; height 4.50 mm.

Remarks. — A single fragmentary left valve is here questionably referred to Furon's species. Though the hinge line is incomplete, it conforms with features of Furon's type in having six small teeth which are more or less vertical to the hinge axis in the middle of the hinge line. They are surrounded laterally by much heavier, convergent lateral teeth.

In the Nigerian specimen here referred to *G. (G.) subtogoensis,* the valve is more trigonal, more convex, and the hinge line heavier and more elevated with a more prominent ligamental area than in Furon's illustrated type. The specific assignment is based solely on the dentition.

Glycymeris (?Glycymeris) guineensis Adegoke, new species
Pl. 34, figs. 3-4

Description. — Shell medium-sized, equilateral, suborbicular with straight hinge line. Beak small, orthogyrate. Ligamental area reduced, with vaguely marked chevrons. Cardinal area broad and slightly arched, bears five teeth on either side of the beak of which the third from the center is most prominent. Teeth strongly convergent, the outermost two on both sides being horizontal. Teeth reduced below the beak to three weak ones joined at the base.

Exterior sculpture consists of a reticulate meshwork of subequal axial and concentric ribs, separated in both cases by interspaces which are narrower than the ribs. Radial ribs tend to bifurcate unevenly near the ventral extremity. Interior ventral margin finely crenulate. Crenulations coincide with the position of interspaces between major primary ribs and can be traced hinge-ward for the greater height of the shell. Shell thin and fragile, lined internally by a thin, transparent calcareous layer.

Material. — The holotype only.

Type. — Holotype, UIMG No. 424.

Dimensions. — Length 10.3 mm; height 9.6 mm.

Remarks. — This elegant species is characterized by its suborbicular shell, the straight hinge line, slightly curved cardinal area, the strongly convergent teeth the outer members of which are horizontal and the sculpture in which concentric and radial ribs are subequally developed.

Though the sculpture and the thinness of the shell are unusual for *Glycymeris s.s.* the reduction of teeth at the center of the hinge line, the orthogyrate beak, and the crenulated interior ventral margin suggest affinities with *Glycymeris s.s.* (Nicol, 1945; 1950a).

The new species may be distinguished from *Glycymeris (Glycymeris) subtogoensis* Furon by its thinner, flatter, more orbicular shell, the straighter hinge line with fewer, heavier, more oblique teeth and the finer crenulations of the interior ventral margin.

Glycymeris sp. A Pl. 34, figs. 5, 6

Dimension. — Length 5.9 mm.

Illustrated specimen. — UIMG No. 425.

Remarks. — A fragmentary, thin-shelled left valve of an indeterminate *Glycymeris* was collected at Ewekoro. The valve is convex; both beak and umbo are small. Hinge line is arched, armed with few heavy strongly convergent teeth. Middle section is broken.

Shell exterior ornamented by numerous, fine radial threads, intersected by equally numerous and fine, but less prominent concentric threads.

The morphologic features of this species readily distinguish it from the other described species from West Africa. It may represent a new species probably closely related to *G. (G.) togoensis* and *G. (G.) subtogoensis*.

Glycymeris sp. B Pl. 50, figs. 20-22

Illustrated specimens. — UIMG No. 569, USNM Nos. 185592, 185593.

Dimensions (mm). —

	height	length
UIMG 569	9.0	9.8
USNM 185592	12.0	12.0
USNM 185593	10.6	10.1

Remarks. — Three moderately small, thick-walled specimens of *Glycymeris* were collected from the Ewekoro quarry. They are worn and thus, cannot be definitely assigned to any of the species described above. The finely beaded ribs are suggestive of *G. togoensis* (Oppenheim).

Subgenus **EWEKOROMERIS** Adegoke, new subgenus

Diagnosis. — Shell small, with suborbicular outline, equivalved and equilateral. Beak minute, orthogyrate, umbo and shell moderately inflated. Hinge line arched, with about four or five teeth on each side of the beak of which the outer two are almost horizontal. Interior margin of shell thickened, completely smooth, and devoid of denticulations.

Shell sculptured exteriorly by a series of broad concentric ridges separated by interspaces about one-third the width of the ribs. Concentric ribs crossed by narrow, but conspicuous radial ribs whose interspaces widen ventrally.

Type species. — *Glycymeris (Ewekoromeris) ewekoroensis* Adegoke, new species.

Remarks. — The new subgenus is here retained within the family Glycymerididae because of its suboval, equilateral outline, the small, subcentral, and orthogyrate beak the absence of siphonal gape, the concentric and radial sculpture and the typical glycymerid teeth.

The subgenus bears superficial resemblance to the Limopsidae especially *Limopsis* on account of the smoothness of the interior border of the shell. It differs by its straight hinge line, the equilateral shell, and the subequal adductor muscle scars.

It may be necessary to elevate *Ewekoromeris* to full generic status when additional specimens become available.

Glycymeris (Ewekoromeris) ewekoroensis Adegoke, new species
Pl. 34, figs. 7, 8

Description. — Same as for subgenus.

Material. — The holotype only.

Type. — Holotype, UIMG No. 426.

Dimension. — Length 3.60 mm; height 3.55 mm.

Remarks. — This new species is characterized by its suborbicular shell, the exterior sculpture in which concentric ribs are more prominent than radial elements, the arched hinge line with few teeth, and the thickened, interior peripheral margin devoid of denticulations.

Order MYTILOIDA Ferussac, 1822

Superfamily **MYTILACEA** Rafinesque, 1815

Family **MYTILIDAE** Rafinesque, 1815

Genus **MYTILUS** Linnaeus, 1758

Mytilus nigeriensis Adegoke, new species Pl. 34, figs. 9, 10

Description. — Shell medium-sized, moderately thick-walled, with an obtusely rounded posterior margin. Umbonal-ventral ridge well developed, prominently elevated, marking off a narrow, steeply inclined antero-dorsal margin and a broadly convex postero-ventral margin. Umbonal ridge continues posteriorly toward margin where it becomes broadly rounded and ill-defined.

Shell ornamented by numerous, uneven, and broad growth rugae on which finer concentric threads are superimposed. Rugae become more prominent, more numerous, and closer spaced near ventral margin. Radial striations not observed. Interior structure unknown.

Material. — An incomplete left valve.

Type. — Holotype, UIMG No. 427.

Dimensions. — Height (incomplete) 44.8 mm; width 32.9 mm; height of shell 14.4 mm.

Remarks. — This species is represented by an incomplete but well-preserved left valve with the anterior end missing.

The specimen is assigned to *Mytilus* rather than to the *Mytilus*-like genus *Acesta* because of its narrow, wedge-shaped shell, the sculpture consisting of indefinite growth rugae rather than ribs, the high umbonal ridge and the seeming lack of radial sculpture.

Olsson and Richards (1961, p. 6, pl. 1, fig. 1) described an almost smooth *Acesta* from the Colombian Tertiary. The latter is much flatter than the present species, and bears well-defined, narrow, distant concentric ribs.

The present record is significant because mytilids are rare in the Tertiary of West Africa.

Subfamily **MODIOLINAE** Keen, 1958

Genus **MODIOLUS** Lamarck, 1799

Modiolus sp. indet. Pl. 34, figs. 11, 12

Illustrated specimen. — UIMG No. 428.

Dimensions. — Height 4.2 mm; width 3.1 mm.

Remarks. — A single specimen of a short, strongly biconvex *Modiolus* was retrieved from the Ewekoro material. It is a cast of the exterior though traces of much of the external sculpture has been removed. The shell is short along the umbonal-ventral axis, with a prominently raised umbonal ventral ridge. In these features, the species is vaguely comparable with *Modiolus furoni* Freneix and Gorodiski from the Lutetian of Diokoul, Senegal.

Its short, inflated shell may be readily distinguished from the narrow, curved shell of *Kitsonia paleocenica* Adegoke, new species, described below.

Subfamily **LITHOPHAGINAE** Adams and Adams, 1857

Genus **LITHOPHAGA** Röding, 1798

Lithophaga turneri Adegoke, new species Pl. 43, figs. 20-22

Lithophaga sp. Adegoke, 1972b, pl. 2, fig. 12.

Description. — Shell small, slightly compressed laterally, slightly higher than wide; beak indistinct, located near the anterior end. Anterior margin truncated, almost as high as rest of shell. Shell widens gently posteriorly, posterior margin incomplete, probably truncated.

Shell beautifully sculptured by distinct, concentric growth striae; vertical striations are absent. Left valve larger than and overlaps the right valve ventrally (Pl. 43, fig. 22). Details of interior of valve and hinge area not known.

Remarks. — This species represents one of the oldest recorded *Lithophaga*. Records are from Paleocene to Recent (Soot-Ryen *in* Treatise, 1969, Palmer and Brann, 1965). This species is characterized by its subcylindrical shell which widens posteriorly, the sharply truncated anterior and posterior ends, and the ventral overlapping of the right valve by the larger left valve.

The absence of vertical striations precludes the new species from the subgenus *Lithophaga s.s.* Collection of additional material may warrant recognizing the new species as the type of a new subgenus.

The new species is named in honor of Dr. Ruth Turner, Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts.

Material. — A single, well-preserved specimen.

Type. — Holotype, UIMG No. 562.

Dimensions. — Height 6.90 mm; length (incomplete) 14.15 mm; thickness of both valves 6.16 mm.

Family Uncertain

Genus **SOOTRYENELLA** Adegoke, new genus

Diagnosis. — Shell small, strongly biconvex, thicker than high, truncated anteriorly and posteriorly. Beaks distinct, strongly incurved, located at the extreme anterior margin of shell, far below the strongly arched umbo. Dorsal margin strongly arched convexly, ventral margin strongly concave.

Valves consist of a series of overlapping plates, running from the anterior to the posterior edges, several of these calcareous plates are visible on the dorsal and ventral surfaces. Shell lamellae sculptured by fine growth striations. Details of hinge and interior of valves unknown.

Type species. — *Sootryenella ewekoroensis* Adegoke, new species.

Sootryenella ewekoroensis Adegoke, new species Pl. 43, figs. 15-19

Pholad, n. sp. Adegoke, 1972a, pl. 1, fig. 8.

Description. — Same as for genus.

Material. — The holotype only.

Type. — Holotype, UIMG No. 125.

Dimensions. — Height 11.5 mm; length 22.0 mm; thickness of both valves 13.0 mm.

Remarks. — This new genus and new species is uniquely characterized by the possession of valves composed of a series of overlapping lamellae each running from the hinge to the ventral surface (Pl. 43, figs. 15, 17, 19). Their edges are distinctly displayed as a series of linear lamellae of uneven thickness on the ventral view (Pl. 43, figs. 17, 19). Other diagnostic features include the strongly curved beaks which are located at the extreme anterior margin below the umbo, the concave ventral margin and the fine concentric sculpture.

The new genus is named in honor of Professor Tron Soot-Ryen, University of Oslo, Oslo.

Subclass PTERIOMORPHIA Beurlen, 1944

Order PTERIOIDA Newell, 1965

Suborder PTERIINA Newell, 1965

Superfamily **PTERIACEA** Gray, 1847

Family **MALLEIDAE** Lamarck, 1819

Genus **VULSELLA** Bolten in Röding, 1798

Vulsella walleri Adegoke, new species Pl. 34, figs. 13-15

Description. — Shell thin, medium-sized, dorso-ventrally elongated and flattened, with an irregular surface. Beak small, acutely pointed, slightly opisthogyrate. Anterior dorsal margin short and straight, merges at an angle of almost 90° with the gently rounded anterior margin. Posterior dorsal margin elongate, merges at a high angle with the straight posterior margin.

Posterior half of shell more expanded and flatter than anterior half, both are separated by an oblique, weakly raised, umbonal-ventral ridge.

Shell surface ornamented by concentric growth striae made more conspicuous by the alternation of narrow cream colored bands with broader grey bands. The concentric lamellae become wavy near the posterior margin. Radial costulation is discernible near the ventral margin of shell. Shell surface with smooth finish and irregular undulations.

Material. — Three complete left valves.

Types. — Holotype, UIMG No. 430; paratypes, UIMG No. 429, USNM No. 174898.

Dimensions (mm). —

	length	height
UIMG 429	19.40	18.65
UIMG 430	27.65	30.15
USNM 174898	23.75	31.10

Remarks. — This species is characterized by its flattened surface with the alternating dark- and cream-colored bands, the small pointed beak and faint radial costae near the ventral margin.

Features of the interior of the valves are not exposed and all the three specimens collected are left valves.

Vulsella walleri Adegoke, new species is more squat than all the Mokattam species described by Oppenheim (1903, pl. 6) except *V. eymari* Oppenheim. The latter has a more undulating posterior margin and concentric lamellae than the present species. It similarly differs from the obliquely elongate Pakistani species described by Eames (1951, figs. 33-38).

The various Senegalese Eocene species (Tessier, 1952, pl. 19, figs. 7-10; Freneix and Gorodiski, 1963, pls. 12, 13) differ by having strongly raised concentric ribs.

The new species is named in honor of Dr. T. R. Waller, Smithsonian Institution, Washington, D.C.

Superfamily **PECTINACEA** Rafinesque, 1815

Family **PLICATULIDAE** Watson, 1930

Genus **PLICATULA** Lamarck, 1801

Subgenus **DARTEPLICATULA** Freneix and Gorodiski, 1963

Plicatula (Darteplicatula) gorodiskii Adegoke, new species

Pl. 35, figs. 1-2

Description. — Shell small, with subovate, slightly elongate outline. Beak small, subterminal. Umbo of upper valve highly inflated, behind it is a concave concentric zone beyond which the ventral margin is flattened to convex. Lower valve bears a flattened attachment area near hinge.

Ventral portion of both valves thrown into four broad radial folds separated by narrow interspaces. Folds are narrow near the concave depression behind the umbonal arch but widen rapidly as they approach the ventral margin. Internal features are unknown.

Material. — The holotype only.

Type. — Holotype, UIMG No. 431.

Dimensions. — Length 4.0 mm; height 4.5 mm.

Remarks. — This species is characterized by its small size, the inflated, smooth umbonal region and the irregular ventral margin folded into four prominent costae. The species resembles Senegalese specimens figured by Freneix and Gorodiski (1963, pl. 4, figs. 4, 5) but differs by its more extensive inflated umbonal region with the concave depression behind it, and the axial ribs are fewer.

The few axial costae and the inflated umbonal region also distinguishes *O. gorodiskii* Adegoke, new species, from the indeterminate *Plicatula* recorded by Freneix and Gorodiski (1963, pl. 5, figs. 3a, b) from the Maestrichtian-Paleocene boundary in Senegal.

It also closely resembles the indeterminate *Plicatula* recorded by Cox (1952, p. 40, pl. 4, figs. 11a, b) from Apatuema, Ghana, differing only in its fewer axial costae and the less prominent concentric ribbing.

The new species is based on one specimen and is named in honor of Dr. A. Gorodiski.

Plicatula costaeirregularis Adegoke, new species Pl. 35, figs. 3-9

Description. — Shell small, flattened, and irregularly folded. Cardinal area short but broad underscored by a deep and wide subcardinal cavity. Left valve deep, irregularly convex with prominent resilium bounded by gently raised lateral cardinal folds.

Adductor muscle scar is asymmetrically lunate, occupying the postero-ventral portion of the shell. The exterior of the left valve is irregularly folded into a few, large, rounded radial costae which are most prominent on the thin, extreme ventral margin. Right valve flatter than left, gently convex, and irregularly wrinkled, with a small cardinal area and a small, variously shaped exterior attachment area. The margin is also irregularly folded axially.

Material. — Thirteen well-preserved specimens.

Types. — Holotype, UIMG No. 432; paratypes, UIMG Nos. 433-435, USNM Nos. 174899, 174900.

Dimensions (mm). —

	length	height
UIMG 432	8.4	12.0
UIMG 433	4.4	8.0
UIMG 434	4.2	5.2
UIMG 435	6.4	10.4
USNM 174899	7.2	—
USNM 174900	5.0	6.4

Remarks. — This minute species is characterized by its triangular hinge area which is deeply undercut by the subcardinal depressions, the small attachment area with variable shape and the few, irregular axial costae.

The new species differs from *Plicatula (Darteplicatula) gorodiskii* Adegoke, new species by its more irregular, coarser, radial sculpture, and the more prominent cardinal area underlain by the deep submarginal fold.

Superficially, the species resembles *Ostrea sohli* Adegoke, new species, in the small size and the possession of a flattened attachment area. It differs by its relatively smaller attachment area, the lack of a prominent angulated fold, and the radial ribbing of its ventral margin.

Superfamily **ANOMIACEA** Rafinesque, 1815

Family **ANOMIIDAE** Rafinesque, 1815

Genus **ANOMIA** Linné, 1758

Anomia cooperi Adegoke, new species Pl. 35, figs. 10-24

Description. — Shell minute to small, convex, with subcircular outline. Beak and umbo prominent, slightly eccentric.

Hinge line short, edentulous or at best bearing a simple toothlike knob (Pl. 35, fig. 24). Shell sculptured by a few abruptly constricted growth lines and numerous growth striae. Shell exterior smooth and uniformly spherical, occasional shells flattened or gently folded near the margin.

Material. — Sixteen specimens.

Types. — Holotype, UIMG No. 436; paratypes, UIMG Nos. 437-443, USNM 174901-174906.

Dimensions (mm). —

	length	height
UIMG 436	6.6	6.6
UIMG 437	6.6	—
UIMG 438	5.4	—
UIMG 439	5.2	4.0
UIMG 440	4.7	5.0
UIMG 441	3.6	3.9
UIMG 442	8.7	7.6
UIMG 443	8.3	—
USNM 174901	5.0	5.0
USNM 174902	4.2	4.0
USNM 174903	5.6	6.0
USNM 174904	—	7.0
USNM 174905	—	—
USNM 174906	8.6	9.6

Remarks. — This species is characterized by its smooth, uniformly spherical shell, the occasional contricted growth marks, and the general absence of axial or radial sculpture.

In most of the specimens, the tip of the beak is perforated (Pl. 35, figs. 10-13, 15, 17, 18) by muricids.

The new species is named in honor of Dr. A. G. Cooper, Smithsonian Institution, Washington, D.C.

Genus **CAROLIA** Cantraine, 1838

Carolia? freneixi Adegoke, new species Pl. 36, figs. 1-4

Description. — Shell minute, oval, slightly higher than long. Right valve convex near the cardinal margin, flattened around the ventral margin. Umbo and beak eccentric. Convex cardinal region of shell smooth; anterior, posterior, and ventral margins irregularly and finely folded into numerous radial ribs. These exterior radial crenulations are not reflected on the interior surface. Prodissoconch is small, flanked on both sides by the prominently raised articular teeth. Postarticular area deeply excavated.

Material. — The new species is based on the type material only.

Types. — Holotype, UIMG No. 445; paratypes, UIMG No. 446, USNM No. 174907.

Dimensions (mm). —

	length	height
UIMG 445	6.0	6.2
UIMG 446	5.4+	—
USNM 174907	10.40	—

Remarks. — This new species falls within the size range of *Plicatula (Darteplicatula) abrardi* Freneix and Gorodiski. It may be readily distinguished from the latter by its more convex and more eccentric umbonal region and the restriction of the more numerous radial costae to the outer margins of the shell. Besides, the interior of the valve is more deeply excavated and the margin does not show a reflection of the exterior radial costae.

Carolia placunoides Cantraine has a much finer set of radial striations (Douvillé, 1920, pl. 3, fig. 4; Tessier, 1952, pl. 22, fig. 1; Salvan, 1954, pl. 1, fig. 14).

The new species is named in honor of Dr. S. Freneix.

Suborder OSTREINA Ferusac, 1822

Superfamily **OSTREACEA** Rafinesque, 1815

Family **OSTREIDAE** Rafinesque, 1815

Subfamily **OSTREINAE** Vialov, 1938

Genus **OSTREA** Linnaeus, 1758

General statement. — Though oysters are generally common components of Tertiary faunas, they have been sparsely recorded from the West African Paleocene. Vincent (1913) and Furon (1948) recorded single indeterminate species from Togo, and Landana respectively while Cox (1952) had only a doubtful record of *Ostrea choffati* Oppenheim from Ghana. Out of about 10 ostreids reported from Senegal by Tessier (1952) only one, *O. ransoni* Tessier was from Paleocene strata (Chabaglian, 1959). Freneix and Gorodiski's (1963) more detailed study of the Eocene of the same area listed the occurrence of about 30 species and subspecies none of which ranged into the Paleocene. Similarly, only two or possibly three of Salvan's (1954) Moroccan 16 species were from the Paleocene. Parker (1964) also recorded *O. multicostata* Deshayes and an indeterminate species from Sokoto in northern Nigeria.

Ostreids have by contrast, been recorded in large numbers from Eocene strata. Apart from the large numbers of Eocene species in Senegal and Morocco, Newton (1922) and Eames (1957) recorded three species from the Ameki Formation of eastern Nigeria; Oppenheim (1904) reported a species from Cameroons, and Böhm (1926) recorded a *Crassostrea* from southwest Africa. Douvillé's (1920) detailed study also showed the presence of at least 10 species of *Ostrea* in the Eocene of Soudan and Senegal.

In this study, a large and diverse ostreid fauna consisting of about 15 determinate species were collected from Ewekoro. The material is probably an underestimate of the entire oyster fauna of the formation because only specimens which weathered out naturally were collected. Thus, most of the large specimens (probably Crassostreas) which are conspicuous elements of the coquinoidal limestone are absent in the study collection.

The specific and supraspecific classification of oysters has been problemmatic (Stenzel, 1971). This is due primarily to the immense variability of the external morphologic characters shown by oysters. These probably reflect differences in the environment and the sessile habit. There is general lack of accord among workers as to the importance of several taxonomically important morphological characters. Among other features, Thomson (1954) considered presence or absence of denticles, convexity of valves, external ornamentation, position and outline of adductor muscle scars as important in specific diagnosis. McLean (1941) also considered the degree of folding of valve margins and the form of the beaks as important.

As in my earlier study of Californian Neogene oysters (Adegoke, 1969a), the shape and structure of the cardinal area, the presence or absence and disposition of denticles, the position, shape, and orientation of adductor muscle scars are considered significant. External shape (outline), as well as sculpture, were considered only of minor importance.

West African Tertiary ostreids have been described in varying details by different workers, the majority tending to use the genus-group name *Ostrea* in a broad sense. The most comprehensive work to date is by Freneix and Gorodiski (1963) in which Senegal Eocene species were assigned to the subgenera *Ostrea s.s.*, *Angustostrea, Cymbulostrea,* and *Cubitostrea.* They also recognized species of the genera *Flemingostrea* and *Crassostrea.* They left a fair number of species unassigned to any particular subgenus and emphasized the gradational aspects of most of the characters used in the subgeneric diagnosis.

In the present study, attempts to use the subgeneric categories of Freneix and Gorodiski (*op. cit.*) and Stenzel (1971) led to inconsistencies and in some cases chaos. Thus all species except those of *Plicatula* and *Pycnodonte* are here referred to *Ostrea sensu lato.*

Ostrea meunieri Douvillé **nigeriensis** Adegoke, new subspecies
Pl. 35, figs. 5-8

Description. — Shell small, moderately thick, with subtrigonal outline, narrow at the hinge area, broader and rounded ventrally. Cardinal area narrow subtrigonal, slightly broader than high, flattened, with poorly defined cardinal folds and troughs.

Antero-dorsal and postero-dorsal margins thickened, bearing marginal as well as faint pleural denticles. Ventral margin uniformly rounded, merges sharply into the straighter dorsal areas and bears marginal and short pleural denticles. Adductor muscle scar large, with an asymmetrical hemispherical outline, slightly wider than high.

Shell exterior ornamented by closely spaced concentric lamellae. Ventral margin thrown into few, broadly rounded axial folds on which finer radial threads are superimposed.

Material. — Two specimens.

Types. — Holotype, UIMG No. 447; paratype, USNM 174908.

Dimensions (mm). —

	height	length
UIMG 447	41.75	31.70
USNM 174908	—	20.0

Remarks. — The most important morphological features of this species such as the subtrigonal outline, the flattened cardinal area, the marginal and pleural denticulations, and the radially folded ventral margin are strongly suggestive of *Ostrea meunieri* Douvillé, (Douvillé, 1920, p. 162, pl. 4, figs. 5, 6; Tessier, 1952, p. 331, pl. 22, figs. 3-9; Freneix and Gorodiski, 1963, p. 61), hence the specific assignment. The new subspecies differs from the typical subspecies by its more arcuate dorsal margin, the larger, more dorsally located, and more asymmetrical adductor muscle scar and the less prominent pleural denticulations.

It differs from *O. meunieri angustilobata* Freneix and Gorodiski (1963) in lacking the posterior discrete lobe characteristic of the latter.

Ostrea sohli Adegoke, new species Pl. 36, figs. 9-17

Description. — Shell small, thin, ovate, higher than wide. Cardinal area, narrow, small, trigonal, strongly recurved toward the posterior margin. Left valve with well-developed triangular resilium bounded by lateral folds of which the anterior is much wider than the posterior.

Shell exterior exhibits variable degrees of convexity. In general, cardinal and median areas are depressed or flattened as a result of attachment, rest of the shell bent, forming a steep slope from this surface and is radially folded. Radial folds uneven, fewer and coarser on lower than on upper margin. The folds are reflected interiorly by crenulations of the interior margin of the shell.

A well-developed auricle is present on most shells. Adductor muscle scar well developed, large for size of the shell, subsymmetrical, with a broad, almost hemispherical outline. Pallial denticles conspicuous especially near the upper (cardinal) area, fainter along the ventral margin.

Material. — Over 20 complete specimens.

Types. — Holotype, UIMG No. 449; paratypes, UIMG No. 448, 450; USNM Nos. 174909, 174910.

Dimensions (mm). —

	height	length
UIMG 448	36.5	36.5
UIMG 449	26.85	25.7
UIMG 450	23.6	17.2
USNM 174909	16.1	13.3
USNM 174910	17.6	11.8

Remarks. — This species is characterized by its small size, the strongly arched shell, the flattened attachment area, and the radially folded ventral margin.

It resembles *Ostrea submissa* Deshayes (Cossmann and Pissarro, 1904-1906, pl. 44, figs. 135-30) but differs by its tendency to develop a much wider and flatter attachment area and the more finely and regularly crenulated interior margin.

The new species differs from *Ostrea plicata* Solander by its broader, more oval shell, and the larger, more posterior adductor muscle scar (Cossmann and Pissarro, 1904-1906, pl. 44; Salvan, 1954, pl. 5, figs. 2-7).

Both Tessier (1952, p. 328, pl. 23, figs. 2, 3) and Freneix and Gorodiski (1963, p. 48, pl. 6, figs. 8-11) recorded *Ostrea (Cymbulostrea) multicostata strictiplicata* (Raulin and Delbos) from the Ypresian and Lutetian of Senegal. The latter species differs from *O. sohli* Adegoke, new species, by its more numerous, closer spaced radial ribs and the absence of an auricle. Both are probably closely related.

O. cayorensis Gorodiski (1950, p. 360, pl. 19, figs. 6-15; Salvan, 1954, p. 46, pl. 3, figs. 16-17) has more numerous narrower and longer radial ribs separated by subequal interspaces.

Ostrea sohli Adegoke, new species, displays considerable morphologic variation. These affect primarily the convexity of shell, the outline, the extent and degree of flattening of attachment area, the slope of the margins, the degree of development of auricle, and the prominence and number of radial folds. These variable features seem to be governed primarily by what valve (left or right) is under consideration, the substrate and the degree of crowding.

This species belongs to the subgenus *Cymbulostrea* as used by Freneix and Gorodiski (1963), and its seems likely that the subgenus was oversplit by them.

The new species is named in honor of Dr. Norman F. Sohl, U.S. Geological Survey, Washington, D.C.

Ostrea kauffmani Adegoke, new species Pl. 37, figs. 1-9

Description. — Shell small, oval to elongate, flattened. Cardinal area small, tending to form a discrete, narrow, elongate area, more or less flattened, with poorly defined cardinal folds and troughs. Beak poorly defined.

Anterior and posteior cardinal margins prominently thickened, bearing numerous coarse marginal denticles. Ventral margin elongate, broadly to subquadrately rounded, with coarse, distant pleural denticles. Adductor muscle scar forms an asymmetrical crescent slightly broader than high, prominently subdivided into two major parts by a median ridge. It is located in the posterior half of oval shells, near the midline of elongate specimens.

Left valve thinner and more oval with small cardinal area, ornamented by concentric laminae. Radial ribs not observed.

Exterior of shell bears close concentric lamellae which are more numerous and closer packed near the outer margins. Narrow outer border bears numerous radial folds (Pl. 37, figs. 2, 3) separated by narrow interspaces.

Material. — Eighteen well-preserved specimens.

Types. — Holotype, UIMG No. 453; paratypes, UIMG Nos. 451, 452, 454; USNM Nos. 174911-174913.

Dimensions (mm). —

	height	length
UIMG 451	23.20	17.60
UIMG 452	16.35	12.05
UIMG 453	37.00	21.40
UIMG 454	34.85	16.80
USNM 174911	25.85	17.40
USNM 174912	21.50	17.70
USNM 174913	31.85	23.80

Remarks. — This species is highly plastic in most of its morphologic features. The shell outline (Plate 37) varies from narrow elongate to quadrately rounded. Though the shape of the adductor scar is identical from valve to valve, its position seems to vary with shell outline, being posterior in ovate and medial in elongate forms.

Ostrea kauffmani Adegoke, new species differs from *O. friryi* Meunier (Douvillé, 1920), by its more elongate shell, the more discrete cardinal area, less conspicuous finer, more marginal radial sculpture, and the marginal and pleural denticulations.

Elongate varieties of *O. kauffmani* resemble superficially *O. resupinata* Deshayes from the Thanetian of the Paris Basin (Cossmann and Pissarro, 1904-1906, pl. 42, fig. 135-6). They differ by their denticulated interior margins and the radially folded exterior margin.

This species mostly falls within the subgenus *Cymbulostrea* as used by Freneix and Gorodiski (1963). A few elongate, curved forms approach species assigned by them to the subgenus *Cubitostrea*. One elongate specimen developed a strongly coiled, *Gryphaea*-like beak (Pl. 37, fig. 6).

The new species is named in honor of Dr. Erle G. Kauffman, Smithsonian Institution, Washington, D.C.

Ostrea sp. indet. Pl. 35, fig. 25

Illustrated specimen. — UIMG No. 444.

Remarks. — A single specimen of an indeterminate *Ostrea* was collected from Ewekoro. It is thick-shelled and resembles *Ostrea kauffmani* Adegoke, new species, in having a crenulate margin, though the crenulation is finer. It has an oval shape in contrast to the mostly irregular shells of *O. kauffmani*. The hinge area is also much smaller than in *O. kauffmani*.

Ostrea durotoyei Adegoke, new species Pl. 37, figs. 10-12

Description. — Shell small, flattened, ovate to subcircular. Hinge area small with small subcardinal depression. A series of small, equidistant pores present along the cardinal edge of the pallial line. Pores more numerous along the anterior dorsal margin than along the posterior margin.

Adductor muscle impression crescentic, located in the cardinal half of the shell. Ventral margin of shell thin and thrown into irregular folds. All collected specimens were attached.

Material. — Three specimens.

Types. — Holotype, UIMG No. 455; paratypes, UIMG No. 456, USNM No. 174914.

Dimensions (mm). —

	height	length
UIMG 455	22.3	21.7
UIMG 456	16.8	18.6
USNM 174914	13.0	16.1

Remarks. — This species is characterized by its small, attached shells, the subcircular outline, and the development of pallial pores. It shares the latter feature, in common with *Ostrea abeokutaensis* Adegoke, new species, from which it may be distinguished by its relatively larger size, the subcircular outline, the absence of a beak, and the flatter shell.

The new species is named in honor of Mrs. Bisi Durotoye, Natural History Museum, University of Ife, Nigeria.

Ostrea abeokutaensis Adegoke, new species Pl. 37, figs. 13-17

Description. — Shell small, thin, fragile, inequilateral, and inequivalve. Right valve deeper and more convex than left valve. Beak small, strongly prosogyrate. Anterior dorsal margin below beak deeply excavated, merging abruptly with the broadly rounded ventral margin. Posterior dorsal margin gently arcuate.

Right valve deep but irregularly convex bearing a flattened attachment area covering most of the cardinal and anterior dorsal margins. Shell surface irregular and wrinkled, sculptured by regularly spaced concentric growth rugae with faint indications of fine radial striae. Cardinal area long and narrow, arcuate, and partially overlapped by anterior margin of shell. Resilium narrow, elongate, V-shaped occupying most of the narrow cardinal area, lateral cardinal folds are indistinct. Anterior and posterior dorsal margins bear a few pallial pores.

Interior surface irregular, flat to depressed. Adductor muscle scar large, semilunar almost symmetrical, located along the axis and occupying the greater part of the posterior ventral region.

Material. — Four specimens of which two are articulated.

Types. — Holotype, UIMG No. 458; paratypes, UIMG Nos. 457, 459, USNM No. 174915.

Dimensions (mm). —

	height	length
UIMG 457	5.0	3.9
UIMG 458	2.1	1.5
UIMG 459	6.5	5.0
USNM 174915	5.9	5.2

Remarks. — This species is characterized by its small size, the strongly prosogyrate beak, the arcuate hinge area, the concave anterior dorsal margin, and the unequal, inequilateral valves.

It resembles *Ostrea uncinata* Lamarck from the Lutetian of Grignon (Cossmann and Pissarro, 1904-1906, pl. 44, figs. 135-33) but differs by its smaller size, the smaller, more arcuate beak with a smaller gap between it and the valve margin.

The new species is also closely comparable with *O. hessi* Mayer-Eymar (Oppenheim, 1903, p. 31, pl. 2, figs. 2, 16, 16a) from the Mokattam. They differ in that the new species has a more regular concentric sculpture.

Ostrea olowui Adegoke, new species Pl. 38, figs. 1, 5, 6

Description. — Shell moderately large, thick, with a multi-layered lamellose exterior, narrow at the cardinal margin, widening rapidly ventrally.

Cardinal area narrow, trigonal, prominently curved. Left valve with well-developed resilium curved near the apical end, bounded by subequal anterior and posterior lateral cardinal folds. Shell widens rapidly below cardinal area, prominently divided into two areas: an irregularly depressed central region bounded by the pallial line and a peripheral area flattened and folded irregularly.

Closely spaced pallial denticulations are developed around the entire shell margin, they are less conspicuous on the ventral margin. Posterior adductor muscle scar large, located posteriorly near the midline with a broad, asymmetric, hemispherical outline. Exterior of shell not fully exposed, composed of several thin lamellae (Pl. 38, fig. 5).

Material. — The species is based on two specimens.

Types. — Holotype, UIMG No. 460; paratype UIMG No. 461.

Dimensions (mm). —

	height	length
UIMG 460	94.1+	71.3
UIMG 461	85.2	88.0

Remarks. — This species is characterized by its moderately large shell, the narrow, curved cardinal area, the pleural denticulations, the expanded, flattened exterior margin, and the many-layered, lamellose exterior (Pl. 38, fig. 5).

It is comparable with *Gigantostrea trigonalis* (Conrad) (Harris *in* Harris and Palmer, 1946, p. 21, pl. 4, figs. 1, 6) but differs by its more strongly curved hinge area, the shallower sub-cardinal cavities and the finer, more complete development of pallial denticles.

The new species is named in honor of Mr. J. A. Olowu, Deputy Director, Geological Survey of Nigeria, Kaduna.

Ostrea paleomarginidentata Adegoke, new species

Pl. 38, figs. 3, 4, 7-9; Pl. 39, figs. 1-3

Description. — Shell small to medium-sized, moderately thick, flat to gently convex, oval with a few specimens tending to be elongate. Cardinal margin slightly narrower than ventral margin.

Right valve has a moderately large, flattened cardinal area, with a broad, transversely ridged midcardinal fold, bounded by indistinct lateral cardinal troughs. Lateral margins thickened, strongly crenulated. Interior margin bears pleural crenulations consisting of short, parallel, even-spaced rods which become faint and inconspicuous near the ventral border.

The adductor muscle scar is prominent, with an asymmetrical ovate to lunate outline, located close to the postero-ventral border. Its position on the valve varies considerably but is always slightly posterior of the midline.

Exterior of shell sculptured by several closely spaced concentric lamellae with a smooth finish. No radial plications observed.

Material. — Eleven nearly complete specimens.

Types. — Holotype, UIMG No. 465; paratypes, UIMG Nos. 462-464, USNM Nos. 174917-174919, PRI No. 29839.

Dimensions (mm). —

	height	length
UIMG 462	47.3	29.3
UIMG 463	—	—
UIMG 464	44.6	31.3
UIMG 465	60.5	34.5
USNM 174917	30.0	23.3
USNM 174918	77.2	54.0
USNM 174919	71.0	35.5

Remarks. — This species is indisputably a member of the *Ostrea marginidentata* Wood group. Its morphologic features are essentially similar to those of *O. pseudomarginidentata* Eames (1957, p. 56, pl.

8, fig. 8; Newton, 1922, p. 60, pl. 6, figs. 2-5), the only significant differences are the absence of radial ribs on the new species, its less prominent pleural denticulations, and the more asymmetrical muscle scars.

Because of the close similarity to *O. marginidentata* and *O. pseudomarginidentata,* and its older stratigraphic occurrence, the present species is regarded as ancestral to the latter species.

Ostrea paleomarginidentata Adegoke, (?) new subspecies Pl. 39, figs. 4-7

Illustrated specimens. — UIMG No. 466, USNM No. 174920.

Remarks. — A few incomplete and fragmentary specimens were collected which show identical morphologic features with specimens here referred to *O. paleomarginidentata* Adegoke, new species. The shells are much flatter and thinner and the adductor muscle scar is larger, wider, with a subcircular(?) outline and occupying a more median portion on the shell. These differences are probably sufficiently significant to merit distinct subspecific designation. In the absence of a complete specimen the subspecies is not named here.

Ostrea asseezi Adegoke, new species
Pl. 39, fig. 8; Pl. 40, figs. 1-4; Pl. 41, fig. 4

Ostrea sp. Adegoke, 1972a, pl. 2, fig. 12.

Description. — Shell medium-sized, elongate, moderately thick, moderately and uniformly convex. Cardinal area wide, slightly elongated, narrows abruptly with a recurved tip, transversely crossed by irregular but prominent ridges.

Left valve with shallow, broad, arcuate resilium, bounded by broad lateral cardinal folds. Subcardinal cavity deep.

Pallial denticulations consisting of sub-circular to narrow linear depressions separated by slightly wider flat areas conspicuously adorn the dorsal area, but are weaker ventrally. Adductor muscle impression with a broad U-shaped to semilunar outline, slightly asymmetrical, located dorsally near the middle of shell. Exterior of shell not completely exposed in any specimen; broadly convex, bearing a series of subequal, moderately wide, angulated radial costae separated by subequal, V-shaped interspaces and crossed by numerous growth lines.

Material. — Four mostly incomplete specimens.

Types. — Holotype, UIMG No. 468; paratypes, UIMG No. 467, USNM Nos. 174921, 174922.

Dimensions (mm).—

	height	length
UIMG 467 (incomplete)	—	—
UIMG 468 (incomplete)	60.8+	41.5
USNM 174921 (incomplete)	—	47.5
USNM 174922 (incomplete)	—	—

Remarks.—This species is characterized by its broad, curved cardinal area, the gently convex shell, the large adductor scar, and the chevron-shaped radial costae.

The new species differs from *Ostrea sohli* Adegoke, new species, by its much larger size, the gently convex shell lacking a flattened attachment area, the broader cardinal area, the more symmetrical adductor muscle scar, and the more prominently raised, V-shaped radial ribs.

The cardinal area is reminiscent of that of *O. ludensis* Deshayes from the Bartonian of the Paris Basin. It differs by its more strongly folded, radial ribs, the wider and more marginal muscle scars.

The angulated radial costae of *O. asseezi* Adegoke, new species, resembles those *O. pseudomarginidentata* Eames (Eames, 1957, pl. 8, fig. 8). They may be readily distinguished by the uniformly convex shell of the new species and the absence of the marginal crenulations characteristic of *O. pseudomarginidentata.*

The new species superficially resembles *O. olowui* Adegoke, new species, but may be readily distinguished by its broader and larger cardinal area, the deep subcardinal cavity, the less prominent but coarser pallial denticulations, and its radial costae.

Ostrea omatsolae Adegoke, new species Pl. 40, figs. 5-11

Description.— Shell small, oval, thin-walled with a leathery texture. Cardinal area narrow, short; shell widens rapidly ventral-ward.

Beak small, strongly opisthogyrate. Subcardinal cavity shallow, merging insensibly with the flattened periphery. Peripheral margin slightly crenulate especially near the cardinal border.

Adductor muscle scar small, semilunar, located posterior of the axis and in the ventral half of shell.

Exterior smooth but for growth lines which are wrinkled producing a leathery texture. Peripheral margin bearing near the cardinal area (Pl. 40, figs. 6, 8) a series of short grooves separated by wide smooth areas.

Material. — Twenty-seven complete specimens.

Types. — Holotype, UIMG No. 472; paratypes, UIMG Nos. 470, 471, USNM Nos. 174923, 174924.

Dimensions (mm). —

	height	length
UIMG 470	18.8	15.8
UIMG 471	24.0	17.7
UIMG 472	22.5	15.7
USNM 174923	10.7	6.6
USNM 174924	10.7	5.4

Remarks. — This species is characterized by its minute size, the thin valves with a wrinkled leathery exterior, the small hinge area, and the crescentic adductor muscle scar.

The strongly curved beak is reminiscent of that of some specimens of *Ostrea kauffmani* Adegoke, new species, and *O. abeokutaensis* Adegoke, new species. It may be readily distinguished from the former by its smaller size, the smaller hinge area, and the poorly developed marginal crenulations and from the latter by its larger size, and the absence of pallial pores.

The new species is named in honor of Dr. M. Ebi Omatsola, Shell-BP Petroleum Development Company Limited, Lagos.

Genus **CRASSOSTREA** Sacco, 1897

?Crassostrea, sp. indet. Pl. 38, fig. 2

Illustrated specimen. — UIMG No. 473.

Remarks. — Several incomplete fragments of thick-shelled oysters were collected at the Ewekoro quarry. Their general characteristics are reminiscent of those of *Crassostrea.* The largest of them forms the matrix on the inside of which the types of *Ostrea olowui* Adegoke, new species are attached. Though these large specimens are conspicuous elements of the coquina, complete specimens were not collected because of the highly indurated matrix.

Ostrea spp. Pl. 42, figs. 2, 3

Illustrated specimens. — UIMG Nos. 479, 480.

Remarks. — A large number of indeterminate oysters were collected from Ewekoro. These included a number of incomplete adults and numerous immature, thin-shelled specimens representing more than one species.

Subfamily **PYCNODONTEINAE** Stenzel, 1956

Genus **PYCNODONTE** Fischer de Waldheim, 1835

Pycnodonte ewekoroensis Adegoke, new species
Pl. 40, figs. 12-15; Pl. 41, figs. 1-3, 5

Description. — Shell moderately large, convex near the hinge, becoming flattened near the ventral margin, much higher than long. Cardinal area narrow and small, subtrigonal, wider than broad. On the right valve, the cardinal area bears a wide mid-cardinal fold, bounded by narrow lateral cardinal troughs and a shallow subcardinal depression. Anterior and posterior dorsal margins thickened below the hinge, bear marginal denticles which tend to be reflected on the pleural region of the postero-ventral margin. Anterior denticulated margin thicker than the posterior margin.

Posterior adductor large, broadly crescentic, located near the dorsal margin of the shell slightly below the midline. Exterior of shell ornamented by few widely spaced concentric striae which become more numerous near the ventral margin. They are crossed by numerous fine, wavy, *Placuna*-like radial ribs.

Material. — Eight mostly incomplete specimens.

Types. — Holotype, UIMG No. 475; paratypes, UIMG Nos. 474, 476, USNM Nos. 174925, 174926, PRI No. 29828.

Dimensions (mm). —

	height	length
UIMG 474 (incomplete)	—	—
UIMG 475	82.60	64.05
UIMG 476 (incomplete)	76.50	—
USNM 174925 (incomplete)	—	—
USNM 174926 (incomplete)	50.20	—

Remarks. — This species is characterized by its umbonal-ventral elongation, the highly convex umbonal area, the narrow cardinal margin, the heavily thickened anterior denticulate margin, and the conspicuous radial ribs.

It closely resembles *Ostrea amekiensis* Eames (1957, pl. 8, fig.

7; Newton, 1922, p. 61, pl. 8, figs. 2, 3) in the outline of the shell, shape of cardinal area and the exterior fine radial sculpture. They differ by the more convex shell, the thicker denticulated margin, and the narrower ventral margin of the new species.

Pycnodonte ewekoroensis Adegoke, new species, may be readily distinguished from *P. tabulata* (Sowerby), described and figured by Freneix and Gorodiski (1963) from Senegal, by its more elongate shell, the more crescentic muscle scar, and the finer radial sculpture.

The new species is more convex, more elongate, thicker-shelled, and with a larger cardinal area than *P. nigeriensis* Adegoke, new species.

Pycnodonte nigeriensis Adegoke, new species
Pl. 41, figs. 6-8; Pl. 42, fig. 1

Description. — Shell medium-sized, suborbicular in outline, slightly higher than long. Cardinal area small with weakly developed cardinal folds and troughs. Beak small strongly prosogyrate. Umbo gently convex, rest of the shell is flattened.

Posterior dorsal margin convex, anterior dorsal margin concave, merging smoothly with the rounded ventral margin. Anterior and posterior ventral margins of shell thin, coarsely denticulated anteriorly and posteriorly; denticles are faintly developed on the ventral margin.

Posterior adductor moderate, crescentic with a broader interior lobe, located near the postero-ventral margin of the shell. Shell exterior ornamented by inconspicuous concentric and extremely fine radial striae. Concentric sculpture more prominent tending to become lamellate near the ventral margin.

Material. — The new species is based on the type material only.

Types. — Holotype, UIMG No. 477; paratypes, UIMG No. 478, USNM No. 174927.

Dimensions (mm). —

	height	length
UIMG 477	42.35	38.15
UIMG 478	47.7+	46.25
USNM 174927 (incomplete)	—	77.80

Remarks. — This species is characterized by its suborbicular shape, the flattened shell, the strongly prosogyrate beak, the concave anterior dorsal margin, the convex posterior dorsal margin, the reduced cardinal area, and the complete denticulation of the interior margin.

It is readily distinguished from *P. ewekoroensis* Adegoke, new species, by its flatter, more circular shell, the prosogyrate beak, and the smaller cardinal area. In addition the posterior adductor scar is relatively narrower and located in the posterior half of the shell. The entire interior margin bears pleural denticulations as distinct from the latter in which denticulations are dominantly restricted to the cardinal region.

The new species differs from *O. amekiensis* Eames by its much smaller cardinal area, the narrower prosogyrate beak, and the less conspicuous radial sculpture.

Subclass HETERODONTA Neumayr, 1884

Order VENEROIDA H. and A. Adams, 1856

Superfamily **LUCINACEA** Fleming, 1828

Family **LUCINIDAE** Fleming, 1828

Subfamily **LUCININAE** Fleming, 1828

Genus **PARVILUCINA** Dall, 1901

Parvilucina chavani Adegoke, new species Pl. 42, figs. 4-7

Description. — Shell minute, inequilateral, strongly convex with suborbicular outline, lacking definite areas. Beak small, slightly prosogyrate. Lunule small, subcircular in outline and depressed. Posterior dorsal margin uniformly arched, merging insensibly with the rounded ventral margin. Anterior dorsal margin slightly produced, gently concave below beak, widening out abruptly and steeply inclined as it merges with the rounded ventral margin.

Cardinal area moderately thick; left valve bears two divergent cardinal teeth representing 2 and 4b; and distant laterals; 4b situated near the anterior margin of a broad ridge parallel to the margin. Right valve with well-developed, trigonal 3b which is bifid at the interior end. Shell ornamented exteriorly by numerous fine concentric ribs. Muscle scars narrow and arcuate.

Material. — Two specimens.

Types. — Holotype, UIMG No. 481; paratype, USNM No. 174928.

Dimensions (mm). —

	height	length
UIMG 481	5.1	5.0
USNM 174928	5.3	5.5

Remarks. — This species is characterized by its fine concentric sculpture, the excavated lunule, the slightly extended anterior end and the bifid 3b. The bifid tooth resembles that of *Eomiltha contortus* Defrance (Chavan *in* Moore, 1969, p. N503; Cossmann and Pissarro, 1903-1904, pl. 24, fig. 82-8) but differs in being higher and in lacking well-defined areas.

The species vaguely resembles *Phacoides (Parvilucina) corneti* Cossmann (1908, p. 21, pl. 2, figs. 11-18) but is less oblong and with heavier cardinal teeth.

The new species seems closely related to *Phacoides (Parvilucina) invisus* Vincent from the Landana beds of the Congo. Both have an orbicular outline, convex valves with excavated lunule, concentric sculpture and divergent 2 and 4b. They differ in that *P. chavani,* new species, is more orbicular with finer concentric sculpture.

The well-developed dentition seen on both valves of this species and *P. invisus* (Vincent) is in marked contrast to the narrower hinge with weaker teeth seen on other species within the genus. This suggests a separate subgeneric affinity for these West African forms. Additional material may warrant erecting a separate subgeneric name for them.

The new species is named in honor of the late Professor André Chavan.

Parvilucina elegantissima Adegoke, new species
Pl. 42, figs. 8-10; Pl. 50, fig. 23

Description. — Shell minute, thin, very convex, suboval. Beak small, located in the posterior third of the dorsal margin, weakly prosogyrate. Anterior dorsal margin long, concave, with excavated lunule, merging almost at right angle with the broadly rounded anterior margin. Posterior dorsal margin gently arched, merging imperceptibly with the uniformly rounded ventral margin.

Shell interior smooth, glossy. Interior margin finely denticulate.

Denticles continue as narrow radial ribs on the interior surface of the shell. Hinge area of right valve narrow, bears a narrow cardinal 3b, oriented vertically in the middle of the cardinal area, and bordered laterally by two subtrigonal sockets. Its apical end is continuous with the raised, concave anterior dorsal margin. The anterior lateral A III is well developed, separated from the margin by a deep groove. The posterior lateral is gently elevated in the cardinal area and it forms a prominent P III at the extreme posterior margin.

Shell exterior beautifully sculptured by regular, equidistant, lowly, flat ribs separated by interspaces that are slightly wider than the ribs.

Material.—The new species is based on the type specimens only.

Type.—Holotype, UIMG No. 482; paratypes, UIMG No. 563, USNM No. 174929.

Dimensions (mm).—

	height	length
UIMG 482	2.05	2.1
USNM 174929	—	—

Remarks.—This new species is known from a well-preserved right valve and fragments of two other valves. It is characterized by its elegant concentric exterior sculpture, the fine crenulations of the interior margin which are continued as faintly raised radial ribs on the interior of the valves. The dentition, consisting of a moderately narrow 3b and well-developed A III and P III further distinguish the species from described lower Tertiary species of *Parvilucina.*

P. elegantissima Adegoke, new species, may be readily distinguished from *P. chavani* Adegoke, new species, by its smaller size, its more oval outline, the fewer, more distant, and more prominent concentric ribs.

Subfamily **MILTHINAE** Chavan, 1969

Genus **MILTHA** H. and A. Adams, 1857

Miltha africana Adegoke, new species Pl. 42, figs. 11-13

Description.—Shell medium-sized, subcircular to discoidal, compressed, slightly inequilateral. Beak small, slightly prosogyrate.

Anterior dorsal margin short strongly concave, makes a sharp obtuse angle where it joins the broadly rounded anterior margin. Posterior dorsal margin straight, sloping at an angle of about 35° from beak, makes a sharp angle as it merges with the posterior dorsal margin. Dorsal area undefined.

Sculpture consists of narrow, unequal and unevenly-spaced concentric ribs between which are numerous, finer, uneven threads. Ventral margin bears broad, smoothly rounded ribs separated by linear grooves. Hinge area trigonal. Teeth on left valve consist of a very heavy, trigonal median element (3), anterior to which is a prominently raised, elongate tooth and posterior to it is a heavy, elongate lateral parallel to the shell margin. Interior of shell unknown.

Material. — The new species is based on the type material only.

Types. — Holotype, UIMG No. 483; paratype, USNM No. 174930.

Dimensions (mm). —

	height	length
UIMG 483	17.0	19.0
USNM 174930	20.5+	25.5

Remarks. — Though this species is here referred to *Miltha* based on the generic diagnosis of Chavan (1938, 1969 *in* Moore), the features of the cardinal area especially the heavy dental elements differ from those of species here-to-fore assigned to the genus. On this basis, as well as the absence of a posterior area, the Nigerian material should probably be referred to a new subgenus when additional material becomes available.

The general outline of the new species resembles that of *Parvilucina invisus* (Vincent) (1913, pl. 3, figs. 16, 17) but the latter is much smaller, shorter, more elongate anteriorly, more regularly sculptured, and has a narrower cardinal area and teeth than the new species.

Genus **ANODONTIA** Link, 1807

Subgenus **AFRANODONTIA** Adegoke, new subgenus

Diagnosis. — Shell small-sized, subcircular, highly convex. Posterior area well defined, narrow and marginal. Sculpture consists of irregular, raised concentric lamellae. Beak small, strongly prosogyrate. Hinge edentulous. Lunule small. Entire anterior margin and posterior margin below the beak bear uneven denticles.

Type species. — *Anodontia (Afranodontia) marginidentata* Adegoke, new species.

Remarks. — This new subgenus is characterized by its edentulous shell and the development of a narrow posterior area. Its inclusion in the subfamily Milthinae is based on its general similarity to the edentulous genera *Anodontia* and *Eamesiella,* the nature of its sculpture consisting of faint and irregular concentric lamellae and the long anterior muscle scar. The concave antero-dorsal margin and the development of a narrow, marginal dorsal area also favor generic placement in *Anodontia* rather than in *Eamesiella.*

Anodontia (Afranodontia) marginidentata Adegoke, new species
Pl. 42, figs. 14-17

Description. — Shell small, moderately inflated, inequilateral, subcircular. Beak small, strongly prosogyrate. Umbo gently convex. Anterior dorsal margin short, merges insensibly into the rounded anterior margin. Posterior dorsal margin convex, higher than the beak.

Shell sculptured by several indefinite concentric rugae. Hinge edentulous, bears a weak, oblique median ridge. Anterior margin bears short, linear denticles while posterior margin below the hinge bears inequidistant, rounded, low denticles. Anterior muscle scar elongate and gently arcuate.

Material. — The two types only.

Types. — Holotype, UIMG No. 484; paratype, USNM No. 174931.

Remarks. — This species is presently the only known member of the new subgenus. It is based on two incomplete but well-preserved left valves.

Family **FIMBRIIDAE** Nicol, 1950

Genus **FIMBRIA** Megerle von Mühlfeld, 1811

?Fimbria sp. cf. **F. furoni** Cox Pl. 42, figs. 18, 19

Meretrix (Callista) proxima Deshayes var. *montensis* Cossmann, Furon, 1948, p. 99, pl. 8, fig. 7.
?*Fimbria furoni* Cox, 1952, p. 43, pl. 4, fig. 16.

Type. — Hypotype, UIMG No. 485.

Dimensions. — Height 3.6 mm.

Remarks. — A single, thin-shelled specimen is here doubtfully referred to *Fimbria furoni* Cox. The specimen, though incomplete, has an elongate oval outline with numerous, subequal concentric ribs separated by slightly narrower interspaces in which fine radial striae are barely visible at high magnification. The specimen is not so coarsely ribbed and the anterior margin is not so elongate and flattened as in Cox's specimen. The incomplete specimen illustrated as *Meretrix (Callista) proxima montensis* by Furon (*loc. cit.*) closely resembles and may be conspecific with Cox's species.

The usage of the generic name *Fimbria* for this and the following species follows Nicol's (1950b) usage.

Fimbria subdavidsoni (Furon) Pl. 43, figs. 1-4

Corbis sub-Davidsoni Furon, 1948, p. 100, pl. 8, figs. 10a, b.
Corbis subdavidsoni Furon, Adegoke, 1972a, pl. 3, figs. 9, 14.
Fimbria subdavidsoni Furon, Adegoke, 1972b, pl. 2, figs. 10, 11; 1973, fig. 10.

Material. — Two nearly complete specimens.
Types. — Hypotypes, UIMG Nos. 148, 149.
Dimensions (mm). —

	height	length
UIMG 148	27.40	35.00
UIMG 149	16.75	—

Remarks. — The two specimens here referred to this species agree well with Furon's illustrated type in outline, adult size and in the details of the cardinal area. The external sculpture varies slightly in that the concentric ribs are more numerous and closer spaced.

In general, prominence of ribs varied from one part of the shell to another. In the extreme anterior end of the shell, the concentric ribs present a frilled to chevron-shaped texture and they are as prominent as the radial ribs. In the posterior half, the concentric ribs tend to be broader and more prominent. In the postero-dorsal portion, the radials are thin and widely but evenly spaced, whereas they become almost completely suppressed near the postero-ventral margin. Because of these variations in texture the Nigerian specimens are here considered conspecific with the Togolese species.

As noted by Furon (1948) this species is morphologically almost identical with the Paris Basin Thanetian species *Fimbria davidsoni* Deshayes (Farchad, 1936, pl. 20, figs. 9a, b).

Fimbria africana Adegoke, new species Pl. 43, figs. 5, 6

Description. — Shell small, elongate-oval in outline. Beak small, centrogyrate. Umbo flattened. Posterior dorsal margin elongate, gently convex, merges insensibly into the broadly rounded posterior margin. Anterior dorsal margin elongate, about twice length of posterior margin and more than half height of shell, gently concave and oriented almost perpendicular to the umbonal-ventral axis. It is sharply rounded at the extremity as it merges with the rounded anterior margin. A truncated oblique ridge separates the umbonal area from the extended anterior region. Ventral margin broadly rounded.

Shell beautifully sculptured by narrow, raised concentric ribs separated by interspaces about 2 to 2½ times the width of the ribs. Interspaces crossed by narrower, closer and regularly spaced radial ribs. Space between three radial ribs is about the same as diameter of interspace between adjacent concentric ribs. Details of cardinal area not exposed. Lateral and ventral interior margins finely crenulate.

Material. — The new species is based on the holotype only.

Types. — Holotype, UIMG No. 486.

Dimensions. — Height 9.15 mm; length 14.00 mm.

Remarks. — This elegant species is characterized by its elongate shell, the extended and flattened anterior margin, the conspicuous, regularly spaced fine radial ribs, and the narrow raised concentric ribs.

The new species may be readily distinguished from *Fimbria furoni* Cox by its more elongate anterodorsal margin, the narrower, more distant concentric ribs, and the more conspicuous radial ribs.

The new species is much smaller, thinner-shelled, relatively more elongate, and with fewer ribs than *F. subdavidsoni* (Furon).

Fimbria africana Adegoke, new species most closely resembles and is almost indistinguishable from *F. lamellosa* (Lamarck) from the Lutetian of the Paris Basin (Cossmann and Pissarro, 1904-1906, pl. 22, fig. 78-1), and immature forms of *F. transversaria* Cossmann (Cossmann, 1908, p. 33, pl. 3, figs. 6-11, especially figs. 8 and 9) from the Montian of Belgium. They may be distinguished by the slightly higher antero-dorsal margin of the new species, its more broadly rounded posterior margin, and the less crenulate interior ventral margin.

Genus **PARVICORBIS** Cossmann, 1892

?Parvicorbis sp. indet. Pl. 43, figs. 7, 8

Illustrated specimens. — UIMG No. 487, USNM 174755.

Dimensions (mm). —

	height	length
UIMG 487	1.3	2.0
USNM 174755	1.8	2.05

Remarks. — Two minute, worn specimens from Ewekoro are here referred to *Parvicorbis* Cossmann. They have a subtrigonal shape, slightly protracted posteriorly, with a concave postero-dorsal margin. The shells are not so elongate-oval as the typical form.

Details of exterior sculpture and of the hinge area are unknown. The general outline shows they may be close to the subgenus *Felaniella* Woodring (1928).

Family **UNGULINIDAE** H. and A. Adams, 1857

Genus **DIPLODONTA** Bronn, 1831

Subgenus **DIPLODONTA** s.s.

Diplodonta (Diplodonta) adangmarum Cox Pl. 43, figs. 9, 10

Diplodonta adangmarum Cox, 1952, p. 42, pl. 4, figs. 22a, b.

Type. — Hypotype, UIMG No. 488.

Dimensions. — Height 5.30 mm; length 6.35 mm.

Remarks. — A single articulated specimen, lacking both beaks is here referred to this species. It is small, convex and smooth, differing from the holotype and only known specimen of *D. adangmarum* by its slightly less orbicular shell.

Diplodonta (Diplodonta) nigeriensis Adegoke, new species
Pl. 43, figs. 11, 12

Description. — Shell small, uniformly convex, slightly inequilateral with suborbicular outline. Beak moderate, prosogyrate. Anterior dorsal margin gently concave, slightly longer and more expanded than posterior dorsal margin, both merge imperceptibly into the quadrately rounded ventral margin.

Right valve with narrow, lucinid-type hinge, with a prominent, obliquely oriented, trigonal cardinal tooth (3b), flanked by triangular fossulae the anterior of which is wider than the posterior. Adjoining the anterior margin is a narrow wedge-shaped tooth (3a). Lateral teeth apparently lacking. Interior of valve not fully exposed. Shell sculptured by irregular concentric striae.

Material. — The holotype only.

Type. — Holotype, UIMG No. 489.

Dimensions. — Height 8.5 mm; length 8.5 mm.

Remarks. — This species is slightly larger, more quadrate, with a more prominently prosogyrate beak than *Diplodonta adangmarum* Cox. It is known only from a single, well-preserved right valve.

It has less prominently raised umbonal area and the shell is relatively higher and more orbicular than that of *D. subhoudasi* Tessier (1952, p. 338, pl. 25, figs. 8-11).

Superfamily **CARDITACEA** Fleming, 1820

Family **CARDITIDAE** Fleming, 1828

General statements. — Much controversy surrounds the classification of fossil and living carditids. The literature is profuse with poorly defined generic and subgeneric names that are used almost interchangeably by various workers. The greatest confusion surrounds the names *Cardita, Cardiocardita, Cyclocardia, Cossmannella, Glans,* and *Venericardia.*

Most of these names were proposed originally for isolated groups of specimens and were based on either the shape of the shell or details of dentition or the nature of external sculpture (Dall, 1902; Chavan, 1938a, 1944, 1969; Mayer-Eymar, 1896; Stewart, 1930; Gardner and Bowles, 1939).

Inasmuch as taxonomic characters have not been carefully defined, the names are given different generic or subgeneric status by various workers depending on what characters are considered most significant.

Good examples of the extent of the present state of confusion are shown by the taxonomy of the West African Tertiary carditids. Three of the commonest Paleocene species have been assigned to various genera and subgenera as shown in Table 2 below:

TABLE 2.—SUPRASPECIFIC PLACEMENT OF WEST AFRICAN PALEOCENE CARDITIDS.

Species	Oppenheim, 1915	Furon, 1948	Tessier, 1952
koerti	*Cardita*	*Venericardia*	*Cardita (Venericardia)*
tabligboensis	*Cardita*	*Cardita*	—
togoensis	*Cardita*	*Cardita*	*Cardita (Venericardia)*

A greater degree of confusion is seen in the classification of the Nigerian Eocene carditids. Newton (1922) recorded four species from the Ameki Formation which he assigned to *Cardita.* The same species have since been assigned by various workers to eight different genera and subgenera representing two different subfamilies (see Table 3 below).

TABLE 3.—CONFUSION IN CARDITID NOMENCLATURE ILLUSTRATED BY FOUR SPECIES FROM THE EOCENE AMEKI FORMATION OF EASTERN NIGERIA.

Species	Newton, 1922	Eames, 1957	Chavan, 1938b, 1944, 1969
nigeriensis	*Cardita*	*Glans*	—
triparticostata	*Cardita*	*Glans (Divergidens)*	*Venericardia* (1938b) *Cardiocardita (Cardiocardita)* (1969)
costaenodulosis	*Cardita*	*Glans (Amekiglans)*	*Cossmannella*
costaeirregularis	*Cardita*	*Glans (Bendeglans)*	*Cyclocardia (Cyclocardia)*

From the foregoing, it is apparent that the carditids need to be restudied especially since Chavan's (1952a, 1969) more recent studies have failed to clarify the taxonomic problems (Table 3).

In the present work, the name *Venericardia* is employed as a group name for all the Ewekoro carditids. The subgeneric name *Venericor* Stewart, 1930 is employed for one of the species.

Subfamily **VENERICARDIINAE** Chavan, 1969

Genus **VENERICARDIA** Lamarck, 1801

Subgenus **VENERICOR** Stewart, 1930

Venericardia (Venericor) nigeriana Adegoke, new species

Pl. 49, figs. 19-26

Venericardia, n. sp. Adegoke, 1972a, pl. 3, fig. 21.
Venericardia (Venericor) sp. Adegoke, 1972b, pl. 2, figs. 13, 14.

Description.—Medium-sized, thick-shelled *Venericardia* with subtrigonal outline, slightly longer than high.

Beak narrow, strongly incurved, prosogyrate. Umbo highly arched, producing a deep subumbonal pit below the cardinal area. Posterior dorsal margin gently convex, about ⅔ height of shell, anterior dorsal margin short, slightly depressed below beak, broadly rounded into the antero-ventral margin. Ventral margin gently and uniformly rounded.

Four teeth are present in the left cardinal area, a low, elongate posterior lateral tooth parallel to the postero-dorsal margin and a much shorter, arcuate anterior lateral tooth, both are separated by deep trigonal sockets from the two cardinal elements. The dentition on the right valve is a mirror image of that of the left valve.

Shell ornamented by about 21 prominent, flat-topped ribs which increase in diameter progressively toward the ventral margin, separated by narrow, deep interspaces which are crossed by conspicuous growth lines. Abrupt growth constrictions common near the ventral margins of adult shells.

Material. — Six well-preserved valves.

Types. — Holotype, UIMG No. 158; paratypes, UIMG Nos. 530, 531, USNM Nos. 185044-185046; PRI No. 29841.

Dimensions (mm). —

	height	length
UIMG 158	28.3	32.0
UIMG 530	—	31.6
UIMG 531	—	24.3
USNM 185044	—	26.6
USNM 185045	20.0	20.6
USNM 185046	20.6	23.6

Remarks. — The new species is characterized by its small to medium size, the flat-topped ribs, and the narrow, flat-bottomed interspaces.

The disposition of dental elements in the cardinal area compares favorably with that of *Venericardia planicosta* Lamarck, hence the writer has suggested affinities with that group (Adegoke, 1972a, b, 1973). It is also closely comparable with the American Midway Paleocene species, *V. (Venericor) mediaplata* Gardner and Bowles

(1939, pl. 33). The Nigerian form is thus considered closely related to these contemporaneous forms.

The smooth, flat-topped ribs and the transversely serrated interspaces distinguish this species from most described West African Tertiary *Venericardia* with their characteristic angulated, spiny ribs. It differs further from *Venericardia juneri* Cox (1952) by its heavier shell and the closer spaced, more numerous ribs, It is also much larger, more trigonal, and has fewer ribs than *V. fenyiensis* Cox, also from Ghana.

Venericardia tabligboensis (Oppenheim) Pl. 48, figs. 19-21

Cardita tabligboensis Oppenheim, 1915, p. 29, pl. 2, fig. 4; Furon, 1948, p. 100.

Material. — Three nearly complete specimens.

Types. — Hypotypes, UIMG Nos. 532, 533, USNM No. 185047.

Dimensions (mm). —

	height	length
UIMG 532	1.85	1.8+
UIMG 533	1.95	2.05
USNM 185047	—	—

Remarks. — This species is characterized by its asymmetrical, strongly inequilateral shell. The ribs are narrower, closer spaced and more finely noded than those of *V. koerti* (Oppenheim), *V. costagranosa* Adegoke, new species and *V. juneri* Cox. It is more asymmetrical, less prominently noded, and with less conspicuous lunule than *V. ewekoroensis* Adegoke, new species. The ribs are less prominently raised and closer packed than in *V. angusticosta* Adegoke, new species.

Venericardia koerti (Oppenheim) Pl. 48, figs. 22-26

Cardita koerti Oppenheim, 1915, p. 24, pl. 2, figs. 1a, b.
Venericardia Koerti Oppenheim, Furon, 1948, p. 101, pl. 8, fig. 11.
Cardita (Venericardia) koerti Oppenheim, Tessier, 1952, p. 331, pl. 23, fig. 11; pl. 24, fig. 10; Chabaglian, 1959, p. 150, pl. 3, fig. 12.
Glans koerti Oppenheim, Adegoke, 1972a, pl. 1, fig. 9.

Material. — Eleven mostly fragmentary specimens.

Types. — Hypotypes, UIMG Nos. 126, 534, 535, USNM Nos. 185048, 185049.

Dimensions (mm). —

	height	length
UIMG 126	5.8	6.2
UIMG 534	7.8	—
UIMG 535	3.6	3.5
USNM 185048	6.3	—
USNM 185049	—	—

Remarks. — This species is a common component of all West African Paleocene faunas (Table 1). It has been recorded from Nigeria, Togo, and Senegal. It differs from the other described species by its relatively symmetrical shell bearing about 15 noded ribs separated by moderately wide, U-shaped interspaces.

Venericardia juneri Cox Pl. 48, figs. 27-32

Venericardia juneri Cox, 1952, p. 41, pl. 4, fig. 14.

Material. — Six well-preserved valves.

Types. — Hypotypes, UIMG Nos. 536-538, USNM Nos. 185050-185052.

Dimensions (mm). —

	height	length
UIMG 536	5.4	5.9
UIMG 537	4.2	4.5
UIMG 538	3.8	4.0
USNM 185050	5.3	5.8
USNM 185051	3.3	3.8
USNM 185052	5.7	5.4

Remarks. — This species is briefly but adequately described by Cox (1952). It is characterized by its exterior sculpture consisting of about 17 rounded ribs separated by much wider U-shaped interspaces.

Venericardia ewekoroensis Adegoke, new species Pl. 49, figs. 1-6

Description. — Shell small, subtrigonal. Beak and umbo moderately elevated. Anterior dorsal margin gently concave, subequal to the straighter posterior dorsal margin; both subtend an angle of almost 90° and merge smoothly into the broadly rounded ventral margin.

Shell sculptured by about 16 prominently noded, moderately wide radial ribs, separated by interspaces about as wide as the ribs. Ventral margin flutted, with both valves closing rather tightly (Pl. 49, figs. 3-5). Lunule and escutcheon prominent and wide, the former is elevated (Pl. 49, figs. 3, 4), while the latter is depressed (Pl. 49, fig. 5). Right valve bears a broad trigonal tooth in the mid-cardinal area.

Material. — Fourteen nearly complete valves.

Types. — Holotype, UIMG No. 539; paratypes, UIMG Nos. 540, 541, USNM Nos. 185053-185055.

Dimensions (mm). —

	height	length
UIMG 539	5.8	5.8
UIMG 540	5.2	5.1
UIMG 541	4.6	4.7
USNM 185053	4.4	4.5
USNM 185054	4.6	4.7
USNM 185055	5.9	6.2

Remarks. — This species is characterized by its almost symmetrical shell, the weakly developed umbo and beak, and the broad lunule and escutcheon.

It differs from *V. costagranosa* Adegoke, new species, by its more finely noded ribs, the more orthogyrate beak and the more symmetrical shell. Its ribs are not so highly elevated as in *C. angusticosta* Adegoke, new species. It has more numerous, but less coarsely sculptured ribs than *V. koerti* Oppenheim.

Venericardia costagranosa Adegoke, new species Pl. 49, figs. 7-10

Description. — Shell small, subovate, stout, and thick-walled. Beak strongly prosogyrate, umbo moderately elevated. Anterior dorsal margin short, almost perpendicular to the umbonal-ventral axis. Posterior margin also high, slightly longer than the anterior dorsal margin, both merge insensibly into the broadly rounded ventral margin.

Shell sculptured by about 15-17 moderately wide, coarsely noded ribs, separated by interspaces which are slightly wider than the ribs in the anterior region, but much wider posteriorly. Ribs are fainter in the anterior prolonged flange of the shell.

Adductor muscle scars prominently depressed, anterior scar crescent-shaped, while posterior scar is almost circular. Left valve bears a blunt, trigonal cardinal tooth separated from the narrow, posterior lateral teeth by a deep socket. Interior of ventral margin of shell bluntly crenulated.

Material. — Four complete and six fragmentary valves.

Types. — Holotype, UIMG No. 542; paratypes, UIMG No. 543, USNM Nos. 185056, 185057, PRI No. 29829.

Dimensions (mm). —

	height	length
UIMG 542	13.75	14.00
UIMG 543	14.05	15.00
USNM 185056	11.16	12.80
USNM 185057	9.6	10.60

Remarks. — This species is characterized by its thick, subovate shell, the expanded anterior dorsal margin on which the radial ribs are slightly suppressed, the deeply impressed adductor muscle scar, and the moderately broad, nodose ribs. It is less symmetrical than *V. ewekoroensis* Adegoke, new species, and the ribs are more numerous and broader than those of *V. koerti* (Oppnheim).

Venericardia angusticosta Adegoke, new species Pl. 49, figs. 11-16

Description. — Shell small to medium, thin-walled and almost symmetrical. Beak and umbo weakly elevated, subcentral; outline subquadrate. Anterior dorsal and posterior dorsal margins short, subequal, merging insensibly into the quadrately rounded ventral margin.

Shell sculptured by about 18 narrow, prominently elevated, finely and regularly grooved ribs, separated by interspaces three to four times as wide as the ribs. Interior margin of shell sharply folded at position of ribs, flat in the interspaces.

Right valve bears in the cardinal area a single, asymmetrical, trigonal tooth which is prolonged posteriorly. Lunule distinct, short and subcircular.

Material. — Five complete and six fragmentary shells.

Types. — Holotype, UIMG No. 546; paratypes, UIMG Nos. 544, 545, USNM Nos. 185058, 185059.

Dimensions (mm). —

	height	length
UIMG 544	4.5	4.8
UIMG 545	3.7	3.7
UIMG 546	7.8	9.5
USNM 185058	5.8	6.2
USNM 185059	—	—

Remarks. — The diagnostic features of this species are its subquadrate outline, the narrow, prominently elevated ribs and the reflection of this in the flutting of the ventral margin of the shell, and the obliquely elongate cardinal tooth. Of these, the narrow, high ribs serve to distinguish the species from other described taxa.

Venericardia togoensis (Oppenheim) Pl. 49, figs. 17, 18

Cardita togoensis Oppenheim, 1915, p. 28, pl. 2, fig. 3; Furon, 1948, p. 101.

Material. — Two nearly complete valves.

Types. — Hypotypes, UIMG No. 547, USNM No. 185060.

Dimensions (mm). —

	height	length
UIMG 547	9.8	10.8
USNM 185060	10.8	13.5+

Remarks. — This species is strongly asymmetrical with moderately wide ribs separated by broad interspaces. The ribs tend to flatten near the ventral margin, suggesting probable affinities with *Venericardia (Venericor) nigeriana* Adegoke, new species. *V. togoensis* is widely distributed throughout West Africa (Table 1).

Subfamily **CARDITAMERINAE** Chavan, 1969

Genus **CARDITELLA** E. A. Smith, 1881

Subgenus **CARDITELLA** s.s.

Carditella (Carditella) baloguni Adegoke, new species Pl. 50, figs. 1-7

Description. — Shell minute, trigonal, almost symmetrical.

Beak and umbo weakly elevated. Anterior and posterior dorsal margins subequal, sloping off at a low angle from the beak.

Shell sculptured by few (11-12), broad, low ribs, separated by narrow interspaces. Ribs faint on the anterior and posterior margins. The ribs are conspicuously intersected by numerous, closely packed, concentric growth lines. Lunule and escutcheon poorly defined, narrow.

Cardinal area of right valve bears a single, trigonal tooth, bounded by narrow sockets.

Material. — Twenty six mostly articulated valves.

Types. — Holotype, UIMG No. 548; paratypes, UIMG Nos. 549, 550, USNM Nos. 185061-185063.

Dimensions (mm). —

	height	length
UIMG 548	5.9	5.8
UIMG 549	4.5	4.6
UIMG 550	3.8	3.9
USNM 185061	3.4	3.5
USNM 185062	3.3	3.2
USNM 185063	5.3	6.0

Remarks. — This species is characterized by its minute, subsymmetrical shell, the low, broad ribs separated by narrow interspaces and intersected by prominent growth lines. It is the only species of *Carditella* recorded from the Ewekoro Formation.

The new species is named in honor of Dr. R. A. Balogun, Department of Biological Sciences, University of Ife, Ile-Ife, Nigeria.

Superfamily **CRASSATELLACEA** Ferussac, 1822

Family **ASTARTIDAE** d'Orbigny, 1844

Subfamily **ASTARTINAE** d'Orbigny, 1844

Genus **ASTARTE** J. Sowerby, 1816

Subgenus **ASTARTE** s.s.

Astarte (Astarte) ewekoroensis Adegoke, new species Pl. 43, figs. 13, 14

Description. — Shell small, trigono-elliptical, inequilateral, with short anterior margin and a slightly expanded posterior margin. Anterior margin gently convex, sloping steeply from the beak and merging imperceptibly into the rounded ventral margin. Posterior dorsal margin straight to gently concave, making a noticeable angle where it merges with the elongate postero-ventral margin.

Shell sculptured by several uniform, prominently elevated and moderately broad, concentric ribs with sub-rounded profile, separated by much narrower interspaces. An abrupt growth constriction occurs near the ventral margin.

Right valve bears on the cardinal area, two cardinal teeth of which the anterior is heavier and more elevated; posterior cardinal tooth almost parallel with shell axis. There is a long narrow anterior lateral tooth parallel to the shell margin, while the posterior dorsal margin is bordered by a narrow ridge.

Shell convex and the ventral margin is coarsely but uniformly crenulated.

Material. — The holotype only.

Type. — Holotype, UIMG No. 490.

Dimensions. — Height 2.55 mm; length 2.58 mm.

Remarks. — This species is represented by a single right valve only. It is characterized by its minute size, the subtrigonal outline, and the concentric ribs separated by narrower interspaces.

The new species is almost indistinguishable from the Copenhagen species described as *Astarte trigonula* von Koenen (1885, p. 100, pl. 5, fig. 3; Ravn, 1939, p. 32, pl. 1, figs. 5, 6). They differ only in that the anterior dorsal margin of the new species is straighter, its cardinal teeth heavier, and the anterior lateral tooth less elongate than on *A. trigonula* von Koenen.

Among American Midway Astartes, the new species resembles *Astarte aldrichiana* Harris. The anterior dorsal margin is less arched, the ribs broader, and the teeth more prominent than on Harris' species.

Superfamily **CARDIACEA** Lamarck, 1809

Family **CARDIIDAE** Lamarck, 1809

Subfamily **CARDIINAE** Lamarck, 1809

Genus **CARDIUM** Linnaeus, 1758

Subgenus **CARDIUM** s.s.

Cardium (Cardium) zechi Oppenheim Pl. 46, figs. 17-19

Cardium Zechi Oppenheim, 1915, p. 22, pl. 1, fig. 15; Furon, 1948, p. 99.
?*Cardium* cf. *zechi* Oppenheim, Tessier, 1952, p. 345, pl. 26, fig. 8.

Material. — Over 80 slightly worn adult shells.

Types. — Hypotypes, UIMG No. 381, USNM No. 185039, PRI Nos. 29830, 29831.

Dimensions (mm). —

	height	length
UIMG 381	54.5	49.0+
USNM 185039	49.0	49.5

Remarks. — This species is readily distinguished from other West African Tertiary species by its oval, subsymmetrical shell which is sculptured by about 30 broad ribs which bifurcate near the ventral margin, and the gently arched hinge plate.

The species is one of the most abundant pelecypods collected from the Ewekoro Formation. It is represented in my collection by over 80 adult specimens. The Senegal specimen doubtfully assigned to the species by Tessier (*op. cit.*) appears tetragonal and too asymmetrical for this species. It resembles more closely *Cardium monodi* Tessier.

Cardium (Cardium) guineense Adegoke, new species
Pl. 46, figs. 20, 21; Pl. 47, figs. 1-3

Cardium cf. *halaense* d'Archiac, Oppenheim, 1915, p. 24, pl. 1, fig. 16; Furon, 1948, p. 100 (not d'Archiac, 1853).

Description. — Shell medium-sized, subtrigonal to subquadrate, slightly wider than high. Umbo high, prominently elevated above the straight hinge line. Beak orthogyrate to slightly prosogyrate.

Both valves strongly convex especially near the cardinal area, flattened around the margins, and slightly prolonged posteriorly. Shell sculptured by about 37 coarse, rounded radial ribs separated by narrow interspaces. An abruptly constricted growth mark occurs near the ventral margin of adult shells. Ventral margin thrown into broad, shallow folds.

Material. — Eighteen well-preserved valves.

Types. — Holotype, UIMG No. 526; paratypes, UIMG Nos. 524, 525, USNM Nos. 185040, 185041.

Dimensions (mm). —

	height	length
UIMG 524	39.0	41.0

UIMG 525	36.8	34.0
UIMG 526	46.5	51.0
USNM 185040	40.0	43.5
USNM 185041	37.5	32.0+

Remarks. — This species has been erroneously identified as *Cardium halaense* d'Archiac, an Egyptian species, that attains a comparable adult size. The present species has more inflated umbones, narrower beaks, and a more flattened peripheral margin. Additionally, the radial ribs are fewer but more prominently elevated.

The species shows considerable variation especially in shell outline. Some specimens are suborbicular with gently rounded ventral margins (Pl. 46, fig. 21), while others show a strong subquadrate outline accentuated by the posterior elongation of the shell.

Cardium (Cardium) nicklesi Adegoke, new species Pl. 47, figs. 4-7

Description. — Shell minute, convex, thin, and translucent, with a pale white color. Beak and umbo small, subcentral, prosogyrate.

Hinge line elongate and arched, bearing on the left valve a strong, trigonal cardinal tooth, posterior to which is a small triangular socket. A strongly raised lateral tooth lies medially along the anterior dorsal margin of the shell.

Shell sculptured by about 25 moderately broad radial ribs separated by interspaces that are as broad as the ribs. The interspaces are crossed by fairly prominent growth lines. Ribs bear short spines especially near the umbonal area. Positions of the ribs are reflected on the interior surface of the shell. The extreme anterior and posterior margins are unribbed.

Material. — Three specimens only.

Types. — Holotype, UIMG No. 527; paratypes, UIMG No. 528, USNM No. 185042.

Dimensions (mm). —

	height	length
UIMG 527	5.8+	4.6
UIMG 528	—	—
USNM 185042	3.6	3.8

Remarks. — This small but elegant species is known from three small specimens only. It is characterized by its minute size, the thin, translucent shell, the small beak and umbo, the arched hinge line, and the dentition.

It differs from *Cardium zechi* Oppenheim by its smaller size and the relatively longer and straighter hinge line. The shell is also smaller and relatively more convex than that of *Cardium guineense* Adegoke, new species.

The new species is named in honor of Mr. Nicklés.

Cardium (Cardium) okeziei Adegoke, new species Pl. 47, figs. 8-12

Description. — Shell minute, subovate to subquadrate. Umbo and beak gently raised. Anterior and posterior dorsal margins subequal, merging gently with the broadly rounded ventral margin.

Shell sculptured by about 30 uneven radial ribs, separated by narrow interspaces. The ribs bear a median row of spines and become markedly wider near the ventral margin of adult shells. They are also faintly grooved. Ribs less prominent and more uneven on the anterior and posterior flanges of the shell.

Left valve bears two diverging cardinal teeth on the hinge line and a short but prominent antero-lateral tooth. An elongate but less prominently raised posterior lateral tooth runs parallel to the posterior dorsal margin.

Material. — Six complete and five fragmentary valves.

Types. — Holotype, UIMG No. 551; paratypes, UIMG No. 387, USNM Nos. 185064, 185579.

Dimensions (mm). —

	height	length
UIMG 387	1.5	1.5
UIMG 551	2.0	2.8
USNM 185064	2.3	2.2
USNM 185579	2.0	1.8

Remarks. — This species may be readily distinguished from *C. (C.) guineense* Adegoke, new species, *C. (C.) zechi* Oppenheim, and *C. (C.) nicklesi* Adegoke, new species, by its small size, the more numerous ribs bearing a row of tiny spines each.

The new species is named in honor of Mr. C. N. Okezie, the Director, Geological Survey of Nigeria, Kaduna, Nigeria.

Subfamily **TRACHYCARDIINAE** Stewart, 1930

Genus **TRACHYCARDIUM** Mörch, 1853

Subgenus **TRACHYCARDIUM** s.s.

Trachycardium mamillatum (Furon) Pl. 47, figs. 13-19

Cardium (Trachycardium?) mamillatum Furon, 1948, p. 100, pl. 8, fig. 9.

Description. — Shell medium-sized, gently rounded ventrally, with subtrigonal outline. Umbo strongly arched, with an incurved, strongly prosogyrate beak.

Shell ornamented by about 40 narrow, flat-topped radial ribs, separated by much narrower, moderately deep interspaces. Diameter of ribs about four times that of interspace. Cardinal area simple, consisting of a series of simple lateral teeth and grooves and a stout, raised, knoblike cardinal tooth on the left valve.

Material. — Nine specimens.

Types. — Hypotypes, UIMG Nos. 552-554, USNM Nos. 185580, 185581, PRI No. 29826.

Dimensions (mm). —

	height	length
UIMG 552	13.5	14.0
UIMG 553	20.0	22.0
UIMG 554	26.3	25.1+
USNM 185580	21.8	22.0
USNM 185581	25.0	22.5

Remarks. — This species was only briefly described by Furon. His figure of the holotype was tilted so strongly that it gave the erroneous impression of the presence of a blunt beak and umbo.

Superfamily **MACTRACEA** Lamarck, 1809

Family **MACTRIDAE** Lamarck, 1809

Subfamily **MACTRINAE** Lamarck, 1809

Genus **SPISULA** Gray, 1837

Subgenus **CREPISPISULA** Eames, 1957

Spisula (Crepispisula) nigeriensis Adegoke, new species
Pl. 50, figs. 8-10

Description. — Shell medium-sized, trigonal, subsymmetrical, flattened, with broadly rounded, slightly emarginate anterior, posterior and ventral margins. Beaks narrow, small, situated slightly anterior of the midline, prosogyrate; umbo weakly inflated. Anterior and posterior dorsal margins subequal, descending at an angle of almost 90° from the beak, anterior dorsal margin gently concave.

Cardinal area of right valve bears a trigonal 3a, separated by a parallel-sided furrow from the much larger, grooved 3b, both are divergent. The two anterior lateral teeth are raised and are separated by a deep groove. A I is larger than A III. P I and P III are subequal, elongate and are separated by a shallow groove. They are parallel to the posterior dorsal margin. Shell smooth but for growth lines.

Material. — One complete and one fragmentary valve.

Types. — Holotype, UIMG No. 564; paratype, USNM No. 185589.

Dimensions (mm). —

	height	length
UIMG 564	12.5	15.0
USNM 185589	10.2	—

Remarks. — This species is represented by two well-preserved specimens. Its trigonal ovate shell which is broadly rounded anteriorly and posteriorly is diagnostic.

The new species differs from *Spisula (Crepispisula) amekiensis* Eames from the Ameki Formation (Eocene) of eastern Nigeria by its smaller size, the more ovate shell with more broadly rounded margins, the less prosogyrate beak and umbo, and the smoother shell.

Subgenus **NOTOSPISULA** Iredale, 1930

Spisula (Notospisula) ewekoroensis Adegoke, new species Pl. 50, fig. 17

Description. — Shell minute, oval-subtrigonal. Beak and umbo moderately developed. Anterior dorsal margin moderately long, gently concave; posterior dorsal margin shorter than anterior margin, slightly concave near the beak; both merge smoothly into the rounded ventral margin. A narrow but distinct, umbonal-ventral ridge is present, marking off the flattened posterior margin from the more uniformly convex anterior portion of the shell. Shell sculptured by faint growth striae.

Material. — The new species is based on the holotype only.

Type. — Holotype, UIMG No. 567.

Dimensions. — Height 3.8 mm; length 4.5 mm.

Remarks. — This species is based on one complete specimen. It is well preserved and represents the first recorded *Notospisula* from the West African Tertiary strata. The narrow but distinct postero-dorsal ridge is diagnostic.

Superfamily **TELLINACEA** de Blainville, 1814

Family **TELLINIDAE** de Blainville, 1814

Subfamily **TELLININAE** de Blainville, 1814

Genus **TELLINA** Linnaeus, 1758

Subgenus **ELLIPTOTELLINA** Cossmann, 1886

Tellina (Elliptotellina) kouriatchyi Furon Pl. 45, figs. 1-3

Tellina (Elliptotellina) kouriatchyi Furon, 1948, pl. 8, fig. 4.

Description. — Shell small, trigonal-ovate. Anterior dorsal margin long, sloping gently at an angle of about 30° from the beak, and broadly rounded ventrally. Posterior dorsal margin short, steeply inclined at an angle of about 45° from the beak, subtruncated near ventral margin. Ventral margin gently and uniformly convex. Cardinal area and interior of valve not exposed. Shell exterior worn, probably devoid of sculpture.

Material. — Seven minute specimens.

Type. — Hypotype, UIMG Nos. 491, 492; USNM No. 174932.

Dimensions. —

	height	length
UIMG 491	2.9	4.3
UIMG 492	3.3	5.3
USNM 174932	1.7	2.6

Remarks. — This species was inadequately illustrated and was virtually not described by Furon. The only information he gave was the dimensions (6 mm by 3.5 mm) and the lack of ornamentation.

The West African species differs from *Tellina briarti* Cossmann (1908, p. 12, pl. 1, figs. 5-8) in that the anterior dorsal margin is more steeply inclined and more acutely rounded. The posterior dorsal margin is also more steeply inclined, broader, and abruptly truncated ventrally.

Tellina pakistani Eames (1951, p. 395, figs. 76a, b) is higher, relatively shorter, more trigonal, and with stronger concentric sculpture.

Subgenus **ARCOPAGIA** Brown, 1827

Tellina (?Arcopagia) sp. indet. Pl. 50, fig. 15

Illustrated specimen. — USNM No. 185591.

Dimensions. — Height 6.2 mm; length (incomplete) 7.5 mm.

Remarks. — A single, minute, indeterminate specimen collected from the Ewekoro quarry is here doubtfully assigned to the genus *Arcopagia.* The shell is ovate, with small, subcentral, slightly prosogyrate beak. The anterior and posterior dorsal margins are both high, subtending an obtuse angle at the beak. The ventral margin is broadly rounded and the shell is ornamented by growth striae only. Details of the hinge plate are not known.

Family **DONACIDAE** Fleming, 1828
Genus **NOTODONAX** Feruglio, 1936
Subgenus **PROTODONAX** Vokes, 1945

Notodonax? (Protodonax) nigeriana Adegoke, new species Pl. 50, fig. 16

Description. — Shell minute, highly compressed, moderately thick-walled. Beak small, umbo weakly inflated. Posterior dorsal margin short, slopes at an angle of about 40° from the beak and merges at a prominent obtuse angle with the ventral margin. Anterior dorsal margin long, high, gently concave near the beak, and merges insensibly with the broadly rounded and protracted ventral margin.

A prominent umbonal-ventral ridge producing a strong postero-dorsal angulation is located near the posterior 1/5 of the shell. Shell ornamented by regularly spaced growth lines which make a sharp turn on the postero-dorsal ridge. Details of hinge plate not known.

Material. — The species is based on the holotype only.

Types. — Holotype, UIMG No. 566.

Dimensions. — Height 3.56 mm; length 7.20 mm.

Remarks.—This minute species is characterized by its extremely elongate anterior end, the short posterior end and the postero-dorsal ridge. It closely resembles in these features, members of the subgenus *Notodonax* Feruglio, 1936 recorded to date only from the Upper Cretaceous of North America and South America and southwest Asia. Its subgeneric placement in *Protodonax* Vokes is based on its smooth shell. Should this generic and subgeneric assignment prove correct, the present record would considerably extend both the stratigraphic and geographic range of the genus.

Superfamily **ARCTICACEA** Newton, 1891
Family **ARCTICIDAE** Newton, 1891
Genus **ARCTICA** Schumacher, 1817

Arctica africana Adegoke, new species Pl. 48, figs. 16-18

Description. — Shell thick, moderately large, with trigonal to ovate outline. Umbo and beak heavy, beak prosogyrate. Right valve with a broad cardinal area, bearing a heavy, bifid(?) or grooved(?) cardinal tooth (3b), surrounded by wide sockets. P I narrow, parallel to the posterior dorsal margin. P II merges with the margin. A I narrow, elongate, gently flexed, A III prominently raised but merged into margin, its cardinal edge fuses with the base of the prominently developed anterior cardinal 3a. The hinge area of the left valve is not exposed.

Shell strongly convex, with a moderately long, concave anterior dorsal margin and a subequal gently arched posterior dorsal margin. Shell exterior with a smooth finish, sculptured by numerous, faint concentric threads and distant, uneven growth constrictions.

Material. — Two nearly complete shells.

Types. — Holotype, UIMG No. 529; paratype, USNM No. 185043.

Dimensions (mm). —

	height	length
UIMG 529	27.5	26.3+
USNM 185043	30.0	33.5

Remarks. — This species is based on two fairly complete and well-preserved specimens representing a left and a right valve. The thickness and sturdiness of the shell and the dentition are diagnostic.

The new species differs from *A. islandica* (Linné) by the less prominently raised umbonal-ventral ridge. It closely resembles *A.*

ovata (Meek and Hayden) from the Cannonball Formation (Paleocene) of North Dakota and South Dakota (Cvancara, 1966). It differs by its stouter 3b, narrower A III, and the less produced posterior end.

Family **TRAPEZIIDAE** Lamy, 1920

Genus **KITSONIA** Eames, 1957

Kitsonia paleocenica Adegoke, new species Pl. 44, fig. 1

Description. — Shell small, moderately thick, arched dorsally, length about three times the width. Extreme anterior end not preserved.

Posterior dorsal margin gently arched, merging about midway with the broad, flattened postero-ventral margin. Anterior dorsal margin strongly arcuate, merging near the posterior end with the subacutely rounded ventral margin. A prominent, broadly rounded umbonal-ventral ridge present, it is parallel with the ventral margin.

Shell smooth, composed of many layers of feltlike calcite. Internal structure and hinge area unknown.

Material. — A single poorly preserved specimen.

Type. — Holotype, UIMG No. 493.

Dimensions. — Width 6.50 mm; length 16.35 mm; height of valve 4.95 mm.

Remarks. — This is undoubtedly a species of *Kitsonia* Eames, a genus erected for identical material from the Eocene Ameki Formation of eastern Nigeria (Newton, 1922, p. 100, pl. 11, figs. 4-5; Eames, 1957, p. 68, pl. 9, figs. 13, 14; Keen, *in* Moore, 1969, p. N656, fig. E 132-8a).

Kitsonia paleocenica Adegoke, new species, closely resembles its probable descendant *K. eocenica* (Newton). Both show identical arcuate ventral margin and well-elevated umbonal-ventral ridge. The new species is relatively shorter, more evenly arcuate and with a gentler and more extended posterior-ventral slope than *K. eocenica* (Newton).

Superfamily **GLOSSACEA** Gray, 1847

Family **GLOSSIDAE** Gray, 1847

Genus **GLOSSUS** Poli, 1795

Subgenus **CYTHEROCARDIA** Sacco, 1900

Glossus (Cytherocardia) nigeriana Adegoke, new species Pl. 44, figs. 2-8

Description. — Shell small, strongly convex, thick and obliquely ovate. Beak small, prosogyrate, umbo strongly convex. Posterior dorsal margin short and uniformly arched. Anterior dorsal margin expanded, sloping off less steeply from the beak. Lunule small, oval, depressed but conspicuous (Pl. 44, fig. 3).

Shell ornamented by several moderately broad, flattened ribs separated by narrow, linear interspaces. Several strong abrupt constrictions of growth lines occur on the shell.

Cardinal area of the right valve bears a prominent, trigonal cardinal tooth, a short posterior lateral tooth subparallel to the margin and a short, sharply elevated antero-lateral tooth. Interior of left valve not exposed.

Material. — Twenty-six mostly articulated valves.

Types. — Holotype, UIMG No. 494; paratypes, UIMG Nos. 495, 496, USNM No. 174933, 174934.

Dimensions (mm). —

	height	length	thickness
UIMG 494	5.8	5.5	3.9
UIMG 495	4.9	4.8	3.1
UIMG 496	5.6	5.8	—
USNM 174933	4.7	5.2	—
USNM 174934	4.2	4.3	—

Remarks. — The generic names *Glossus* and *Isocardia* are currently used interchangeably for a variable spectrum of species, typical representatives of which characteristically have strongly coiled and twisted beaks (Lamarck, 1798; Thiele, 1935; Keen and Casey, *in* Moore, 1969). Thiele (1935, p. 858) considered *Glossus* the valid name, and *Isocardia* a synonym while Keen and Casey (*op. cit.*) hold the opposite view. *Glossus* is used here because it predates *Isocardia.*

Among the glossids, species currently referred to *Cytherocardia* Sacco are smaller, more ovate, with smaller, less twisted beaks than *Glossus s. s.* and other subgenera (Keen and Casey, *op. cit.*). The present species as well as that described as (?)*Isocardia thiepensis* by Tessier (1952, p. 336, pl. 24, figs. 6-9) are small, have subtrigonal outlines, strong concentric ribs, and extremely small beaks. They are probably more correctly assigned to *Cytherocardia.*

The Paris Basin Lutetian specimen, *Isocardia cocaenica* de Raincourt (Cossmann and Pissarro, 1904-1906, pl. 16, fig. 67-1) probably belongs to the same genus though its beaks are heavier and more strongly curved than in the West African species.

Glossus (Cytherocardia) nigeriana Adegoke, new species, and *G. (C.) thiepensis* (Tessier) are both closely similar and probably belong to the same stock. They both have steeply inclined, convex, postero-dorsal margins and the anterior margin is expanded. They have well-developed concentric ribs and several major growth constrictions on the shell. The Senegal species is larger than the new species. Closer textural comparison is not possible because of the worn nature of Tessier's figured types.

The new species shows about the same stage of evolutionary development as *Isocardia faxensis* Ravn (1902, 1933).

Superfamily **CORBICULACEA** Gray, 1847

Family **CORBICULIDAE** Gray, 1847

Genus **CORBICULA** Mergele von Muhlfeld, 1811

Subgenus **CORBICULA** s.s.

Corbicula (Corbicula) sp. indet. Pl. 44, fig. 9

Description. — Shell small to medium-sized, trigonal and highly arched. Beak small, slightly prosogyrate. Umbo blunt, gently compressed. Anterior and posterior dorsal margins slope off acutely from the beak, the anterior slope is more steep.

A weak umbonal-ventral ridge runs along the posterior margin. Ventral margin broadly rounded. Cardinal area and interior of valve not well preserved. Shell exterior ornamented by irregular growth marks.

Material. — A single valve.

Illustrated specimen. — UIMG No. 497.

Dimensions. — Height 9.0 mm; length 8.5+ mm.

Remarks. — The general outline of this species is reminiscent of that of the types species, *C. (C.) fluminalis* Müller from Asia Minor (Keen and Casey *in* Moore, 1969, p. N666, fig. E 139-8). It differs by its smaller beak, its more trigonal shell, and the straighter ventral margin.

Corbicula texana Gardner (1933, p. 154, pl. 8, figs. 6, 7) from the Midway of Texas and *C. (Cyanocyclas) chilensis* Soot-Ryen

(1952, p. 309, pl. 1, figs. 5-7) are larger and more ovoid. The former has a wrinkled outer surface, and the latter fine concentric striae.

"Corbicula" serrodentata Adegoke, new species Pl. 44, figs. 10-14, 21, 22

Description. — Shell small, fairly thick, inequilateral. Posterior dorsal margin straight, slopes at low angle from beak. Anterior dorsal margin gently convex, slopes from beak at an angle of about 25°.

Beak small, elevated, subacutely pointed, prosogyrate. Exterior of shell uniformly convex except near anterior dorsal rim which is flattened, shell sculptured by numerous uneven, closely packed concentric ribs. Hinge area of left valve trigonal, with two, heavy cardinal teeth, the anterior of which is heavier than the more elongate posterior cardinal. The latter is sub-parallel to the posterior dorsal margin from which it is separated by a deep trough.

A prominently raised and elongate anterior lateral tooth is located medially along the broad anterior dorsal rim. Its inner margin bears numerous fine serrations (Pl. 44, figs. 12, 13). Ventral margin of shell not preserved.

Material. — Three fragmentary specimens.

Type. — Holotype, UIMG No. 498; paratype, UIMG No. 499, USNM No. 174935.

Remarks. — This species is known from three fragmentary shells. Its diagnostic features are the two heavy cardinal teeth and the prominent anterior lateral tooth with serrated interior margin.

The new species differs from *Corbicula* sp. indet. by its less trigonal shape and the dentition. The generic assignment of the species to *Corbicula* is doubtful, hence the qualification.

Superfamily **VENERACEA** Rafinesque, 1815

Family **VENERIDAE** Rafinesque, 1815

Subfamily **PITARINAE** Stewart, 1930

Genus **PITAR** Romer, 1857

Subgenus **PITAR** s.s.

Pitar (Pitar) ewekoroensis Adegoke, new species Pl. 44, figs. 15-20

Description. — Shell medium-sized, high, with an ovoid outline. Anterior dorsal margin short, gently sloping and merging imperceptibly with the broadly rounded anterior margin. Posterior dorsal margin gently arched, slightly compressed along the margin, makes an obtuse angle as it merges with the broadly rounded ventral margin.

Hinge area straight bears on the left valve two divergent cardinal teeth, of which the anterior (2a) is narrow, sublaminar, and slightly inclined from the umbonal-ventral axis. The posterior cardinal (2b) is trigonal, heavier, more oblique, and reaches the ventral margin of the cardinal plate. Posterior to the latter is an elongate triangular socket.

Anterior lateral tooth well developed, narrow, and elongate, located near the anterior dorsal margin of the hinge plate and separated from the dorsal margin by a linear trough. On the right valve, there are two subequal cardinal teeth of which the anterior is heavier, more trigonal and almost perpendicular to hinge line. An elongate depression occurs along the anterior dorsal rim. Shell surface faintly ornamented by numerous fine concentric striae and occasional more prominent growth constrictions.

Material.—Four adult and several minute, immature specimens.

Types.—Holotype, UIMG No. 500; paratypes, UIMG Nos. 501, 502, USNM No. 174936, PRI No. 29832.

Dimensions (mm).—

	height	length
UIMG 500	18.00	18.34
UIMG 501	17.5	21.1
UIMG 502	27.7	14.8
USNM 174936	12.8	—

Remarks.—This species is characterized by its faint, uneven concentric sculpture, the short anterior lateral tooth, and the strongly developed arcuate cardinal teeth. Its outline is generally like that of "*Corbicula*" *serrodentata* Adegoke, new species, from which it may be readily distinguished by the dental features.

Genus **COSTACALLISTA** Palmer, 1927

Costacallista adabionensis (Oppenheim) Pl. 45, figs. 4-8

Cytherea adabionensis Oppenheim, 1915, p. 30, pl. 2, figs. 5-9.
Meretrix adabionensis Oppenheim, Furon, 1948, p. 99, pl. 8, fig. 6.

Meretrix (Amiantis) adabionensis Oppenheim, Tessier, 1952, p. 348, pl. 27, fig. 9; Chabaglian, 1959, pp. 140, 141, 142, 143.
Macrocallista adabionensis (Oppenheim), Cox, 1952, p. 43, pl. 4, figs. 17-20.

Material. — Eighteen nearly complete shells.

Types. — Hypotypes, UIMG Nos. 503-505, USNM 174937, PRI No. 29833.

Dimensions (mm). —

	height	length
UIMG 503	10.2	15.5
UIMG 504	9.6	12.5
UIMG 505	13.0	14.9
USNM 174937	12.2	15.0

Remarks. — This geographically widespread West African Paleocene species is characterized by its few, distantly spaced lamellate concentric ribs. The ribs are narrow at the base and are folded upwards toward the apex. There are fewer ribs on the right than on the left valves and the wide interspaces are unevenly elevated.

The outline is also fairly distinctive, the height/diameter ratio being higher for this than for any of the other species of *Macrocallista* or *Costacallista.*

The outline and sculptural pattern of this species is closely comparable with those of *Pitaria* [*Pitar*] *(Lamelliconcha) baldryi* Olsson (1930, p. 27, pl. 2, figs. 1, 2) from Yasita, Peru.

Genus **MACROCALLISTA** Meek, 1876

?**Macrocallista aurilitoralis** Cox — Pl. 45, figs. 10, 11

Macrocallista aurilitoralis Cox, 1952, p. 44, pl. 4, fig. 21.

Material. — Nine well-preserved specimens.

Types. — Hypotypes, UIMG No. 506, USNM No. 174938.

Dimensions (mm). —

	height	length
UIMG 506	6.0	7.6
USNM 174938	10.0+	—

Remarks. — A few specimens in my collection are referrable to *Macrocallista aurilitoralis* Cox, a species distinguished from *M. adabionensis* Oppenheim only by its wider ribs separated by interspaces as wide as the ribs and the more broadly rounded extremities (Cox, 1952, p. 44). Additionally, the lunule is ill-defined and is not excavated.

The morphological characters of the species are in general intermediate between those of typical *M. adabionensis* Oppenheim with its few, narrow distant ribs and *M. gruneri* (Oppenheim) with its moderately broad, flat-topped, closely packed ribs.

Macrocallista gruneri (Oppenheim) Pl. 45, figs. 12-16

Cytherea Gruneri Oppenheim, 1915, p. 33, pl. 2, fig. 10.
Meretrix Gruneri (Oppenheim), Furon, 1948, p. 99, pl. 8, fig. 5.

Material. — Eleven specimens.
Types. — Hypotypes, UIMG Nos. 507-510, USNM No. 174939.
Dimensions (mm). —

	height	length
UIMG 507	3.0	3.9
UIMG 508	7.7	9.1
UIMG 509	3.45	4.0
UIMG 510	5.80	6.85
USNM 174939	6.85	8.50

Remarks. — This species is characterized by its trigonal shape, the more angulate anterior and posterior extremities, and the numerous moderately wide, flat, closely packed concentric ribs, separated by narrow interspaces. The lunule is narrow, elongate but ill-defined.

Several specimens referrable to this species were collected from Ewekoro. They tend to be relatively more elongate than Oppenheim's figured type. Besides, occasional slightly deeper concentric furrows tend to separate the ribs into sections each containing between five-seven ribs.

The Senegal specimen figured by Tessier (1952, p. 349, pl. 27, fig. 10) and Chabaglian (1959, pp. 141, 142) is larger and has much wider, flat-topped ribs than this species.

Macrocallista ewekoroensis Adegoke, new species Pl. 45, figs. 17-22

?*Meretrix gruneri* Oppenheim, Tessier, 1952, p. 349, pl. 27, fig. 10; Chabaglian, 1959, pp. 141, 142.

Description. — Shell medium-size, elongate-oval in outline. Beak bluntly pointed, strongly prosogyrate. Umbo flattened. Posterior-dorsal margin elongate, gently convex, truncated and obtusely angulate at the end. Antero-dorsal margin short, concave, flaring out into the broadly rounded anterior ventral margin.

Ventral margin mostly incomplete, probably broadly and uniformly rounded. Lunule moderately long and wide.

Shell ornamented by several flat to gently rounded, uneven but wide ribs, separated by narrow, deep, sublinear grooves. Ribs are moderately narrow on beak and umbo, suddenly increasing in diameter on rest of shell. Teeth on cardinal area of right valve consists of four major elements. An elongate, narrow posterior lateral, and three cardinal elements. The posterior cardinal is slightly elongate and parallel to the postero-lateral tooth. The anterior cardinal is smaller than and is oriented parallel to the stout, trigonal central element.

The dentition on the left valve is closely comparable to that of *M. adabionensis* Oppenheim (Cox, 1952, pl. 4, fig. 17) but the cardinal elements are stouter and less diverging.

Material. — Fourteen well-preserved specimens.

Types. — Holotype, UIMG No. 511; paratypes, UIMG Nos. 512-514, USNM No. 182375, PRI 29827.

Dimensions (mm). —

	height	length
UIMG 511	21.85	19.70+
UIMG 512	10.40	12.20+
UIMG 513	14.40	15.90
UIMG 514	5.70+	—
USNM 182375	15.25	21.10

Remarks. — This new species is characterized by its relatively large size, the elongate postero-dorsal margin, the moderately wide and long lunule, and the broad, flattened ribs separated by narrow, linear grooves. These characters distinguish it from other Macrocallistas recorded from the West African lower Tertiary except that specimen figured as *Meretrix gruneri* (Oppenheim) by Tessier (1952). The latter is large and has relatively broad, closely packed ribs similar to those of the new species but its outline is more trigonal, with a more elongate, concave antero-dorsal margin and a shorter potsero-dorsal margin, the ribs are relatively narrower and the lunule is narrower and less defined.

The new species resembles *Cytherea latesulcata* Oppenheim (1904, p. 264, pl. 7, fig. 20) from the Eocene of Kamerun but has relatively broader ribs and a less ovate outline.

Macrocallista lunulata Adegoke, new species Pl. 45, figs. 23-27

Description. — Shell medium-sized, thin, strongly convex, with subovate outline. Posterior dorsal margin convex, slopes at an angle of about 45° from the subacutely pointed, prosogyrate beak. Anterior dorsal margin excavated, concave, merges inconspicuously with the broadly rounded anterior-ventral margin.

Lunule broad, elongate with its outer margin marked by a prominent linear groove (Pl. 45, fig. 24). Hinge of right valve bears a broad posterior lateral, parallel to the posterior dorsal margin and separated from it by a deep, linear groove. The cardinal elements consist of an elongate divergent posterior tooth and an oval bifid(?) arched central tooth. Anterior edge of the hinge plate flattened, bears a deep groove parallel to the hinge axis.

Exterior of shell smoothly finished, bears very fine growth striae.

Material. — Twenty-four mostly articulated specimens.

Types. — Holotype, UIMG No. 515; paratypes, UIMG No. 516, USNM No. 182376.

Dimensions (mm). —

	height	length
UIMG 515	13.80+	18.65
UIMG 516	15.10	21.0+
USNM 182376	—	17.4+

Remarks. — This species resembles *Macrocallista ewekoroensis* Adegoke, new species, in size but may be readily distinguished by its more oval outline, the external sculpture of fine concentric striae, the smooth exterior finish the more oval shape and the bifid(?) cardinal tooth.

The sculpture and dental pattern similarly distinguishes the new species from other described species of *Macrocallista.*

The new species is represented by several immature and adult specimens which are readily identified by the oval, "bifid" central tooth, and the sharply delineated lunule. The new species is named for the latter feature.

Macrocallista femii Adegoke, new species Pl. 46, figs. 1-8

Description. — Shell minute, oval. Anterior dorsal margin straight to gently concave, slightly longer and more steeply inclined than the posterior dorsal margin. Ventral margin broadly and uniformly rounded.

Shell sculptured by numerous, even, flat-topped concentric ribs separated by narrow interspaces about one-third the width of the ribs. Lunule small but distinct. Escutcheon narrow, long. Teeth of the right valve consists of a single wedge-shaped cardinal flanked by broad sockets (Pl. 46, fig. 6).

Material. — Eleven specimens.

Types. — Holotype, UIMG No. 517; paratypes, UIMG Nos. 518-520, USNM Nos. 182377, 182378.

Dimensions (mm). —

	height	length
UIMG 517	3.05	4.60
UIMG 518	3.75	5.35
UIMG 519	1.8	2.0
UIMG 520	—	5.85
USNM 182377	5.95	4.20
USNM 182378	—	6.55

Remarks. — This elegant species is characterized by its oval outline, the small beak, and the numerous fine concentric ribs. It may be readily distinguished from *M. aurilitoralis* Cox by its less prominently raised beak and umbo and the more uniform and prominent rib development.

The new species is named in honor of my son, Femi Adegoke.

Genus **DOSINIOPSIS** Conrad, 1864

Dosiniopsis ewekoroensis Adegoke, new species Pl. 46, fig. 16

Description. — Shell small, convex, inequilateral. Beak moderate, prosogyrate. Anterior dorsal margin concave below the beak, slightly extended and merges smoothly with the rounded anterior margin. Posterior dorsal margin convex, shorter than the anterior margin, sloping gently from the beak and merging imperceptibly with the uniformly rounded postero-ventral margin. Details of hinge area and the interior surface unknown. Exterior sculptured by fine, uneven, rounded concentric ribs separated by narrower, rounded interspaces.

Material. — The holotype only.

Type. — Holotype, UIMG No. 231.

Dimensions. — Height 7.0 mm; length 7.5 mm.

Remarks. — This species is characterized by its uniformly convex shell, the subcircular outline and the fine concentric sculpture. It is smaller, more orbicular and more regularly sculptured than *D. deweyi* (Meek and Hayden) recorded by Cvancara (1966) from the Cannonball Formation (Paleocene) of North Dakota and South Dakota.

Subfamily **MERETRICINAE** Gray, 1847

Genus **TRANSENNELLA** Dall, 1883

Transennella africana Adegoke, new species Pl. 46, figs. 9-15

Description. — Shell minute, trigonal, lenticular. Beak and umbo small, prosogyrate. Anterior dorsal margin short, slightly concave; posterior dorsal margin straight, slightly protracted posteriorly. Lunule and escutcheon narrow, linear (Pl. 46, fig. 9).

Cardinal area of right valve with three cardinal teeth of which the central element is heavier and wedge-shaped, teeth separated by narrow sockets. A long, narrow postero-lateral tooth runs parallel to the postero-dorsal margin.

Shell ornamented by irregular growth rugae with occasional deep constrictions marking interruptions in normal growth. Constrictions are more common near the ventral margin of the shell.

Types. — Holotype, UIMG No. 555; paratypes, UIMG Nos. 556, 557, USNM Nos. 185582-185584.

Dimensions (mm). —

	height	length
UIMG 555	4.8	6.0
UIMG 556	—	2.9
UIMG 557	6.5+	8.4
USNM 185582	3.2	4.0
USNM 185583	4.0	5.0
USNM 185584	4.8	6.3

Remarks. — This small species is characterized by its subtrigonal shell, the fine, linear lunule, and escutcheon and the exterior sculpture consisting of marked growth constrictions only. It differs from *T. conradina* (Dall), the type species of the genus by its heavier cardinal teeth.

Genus **AEORA** Conrad, 1870

Aeora? africana Adegoke, new species Pl. 50, figs. 18, 19

Description. — Shell small, egg-shaped. Beak small, opisthogyrate, located posterior of the midline. Posterior dorsal margin short, high, truncated abruptly, producing a blunt, widely gaping posterior end. Anterior dorsal margin longer than posterior, gently convex, slopes more uniformly from the beak, making an acute turn into the broadly rounded ventral margin.

Hinge area of the preserved right valve with a prominent, trigonal subcentral 3a and a narrower, curved 3b. Posterior lateral teeth, P I and P III short, separated by a lenticular socket. A I is broad and elongate, separated by a narrow groove from A III which is, in turn, separated from the anterior dorsal margin by a narrow groove. Both A I and A III join the antero-dorsal margin to produce a thickened anterior rim.

The truncated posterior end of the shell bears a moderately wide siphonal gape. Shell is smooth.

Material. — The holotype only.

Type. — Holotype, UIMG No. 568.

Dimensions. — Height 7.6 mm; length 9.8 mm.

Remarks. — This species, represented in my collection by only one specimen, is here questionably assigned to the genus *Aeora* Conrad, 1870, a genus so far known only from the Upper Cretaceous of eastern North America. The generic assignment is based on the comparable dental features. The new species differs from *Aeora cretacea* the type species of the genus by its much longer anterior end and the shorter, more abruptly truncated posterior end which gapes widely.

The wide gape of the new species is reminiscent of those of members of the order Pholadomyoida but the features of the hinge prevent inclusion in that group.

Genus **TIVELINA** Cossmann, 1886

Tivelina ewekoroensis Adegoke, new species Pl. 50, figs. 11-14

Description. — Shell small, moderately thick-walled, gently convex. Beak small, prosogyrous, situated in the anterior ⅔ of shell Anterior dorsal margin short, produced a little anteriorly, merges imperceptibly with the rounded ventral margin; posterior dorsal margin gently convex, not completely preserved. Shell sculptured by numerous concentric ribs which are worn on the two specimens studied.

Teeth on the left hinge area consist of two well-developed, convergent cardinal teeth of which the posterior (2b) is more prominent than the anterior (2a). The base of 2a continues into the elongate A II. P I and P III narrow, they run parallel to the posterior dorsal margin. Muscle scar impression not distinct; margin of the shell smooth.

Material. — Two specimens.

Types. — Holotype, UIMG No. 565; paratype, USNM No. 185590.

Dimensions (mm). —

	height	length
UIMG 565	5.6	5.5
USNM 185590	7.1	8.3

Remarks. — This species is represented by two specimens both of which lack the posterior end of the shell. The species differs from *Tivelina newtoni* Eames from the Ameki Formation of eastern Nigeria by its slightly smaller size, the more ovate anterior end, the more prominent dentition, and the weaker concentric sculpture.

Order MYOIDA Stoliczka, 1870

Suborder MYINA Stoliczka, 1870

Superfamily **MYACEA** Lamarck, 1809
Family **CORBULIDAE** Lamarck, 1818
Subfamily **CORBULINAE** Gray, 1823
Genus **CORBULA** Bruguière, 1797

Corbula atlantica Furon — Pl. 48, figs. 8-15

Corbula atlantica Furon, 1948, p. 98, pl. 8, fig. 2; Chabaglian, 1959, p. 152, pl. 3, fig. 13, text-fig. 6; Adegoke, 1972a, pl. 1, figs. 5-7.

Description. — Shell small, subtrigonal, inequilateral, inequivalve. Right valve larger and more elongate than left valve. Anterior dorsal margin uniformly rounded, posterior margin truncated, with an acutely pointed and gently twisted posterior end. Valves ornamented by narrow, widely spaced concentric ribs which cross the posterior truncation almost at right angles.

Hinge area of right valve bears a relatively wide and deep median socket near the anterior edge of which there is an elongate process. The left cardinal area has a shallow median socket bounded laterally by low ridges. Right valve margin overlaps the left valve ventrally. Posterior adductor muscle scar located on a raised shelf below which the shell is deeply excavated.

Material. — Thirteen well-preserved specimens.

Types. — Hypotypes, UIMG Nos. 558, 559, USNM Nos. 185585, 185586.

Dimensions. —

	height	length
UIMG 558	6.2	9.5
UIMG 559	5.3	8.3
USNM 185585	4.8	7.2
USNM 185586	5.6	9.8

Remarks. — This species was only briefly described by Furon. It has a widespread geographic distribution in West Africa (Table 1). It may be readily distinguished from other species by its relatively larger size, the distant concentric ribs, and the strongly convex valves.

Corbula nigeriensis Adegoke, new species — Pl. 48, figs. 1-7

Description. — Shell small, trigonal, inequilateral, inequivalve. Right valve longer than left valve and overlaps it markedly posteriorly. Valves strongly convex. Anterior dorsal margin slopes gradually to a broadly rounded anterior end. Posterior dorsal margin convex, abruptly truncated posteriorly and dropping almost vertically to the broadly rounded ventral margin. Ventral rim of shell thick and flattened.

Right valve bears a socket, bordered antero-ventrally by a raised knob located on a ledge. Cardinal area of left valve bears only a median socket for the knob on the right valve. Right valve ornamented by closely spaced concentric ribs which are conspicuous only near the ventral margin of the shell. Left valve smooth but for growth striae, with a prominently angulated umbonal-ventral ridge forming a shelf which broadens posteriorly.

Material. — Thirty-six well-preserved specimens.

Types. — Holotype, UIMG No. 560; paratypes, UIMG No. 561, USNM Nos. 185587, 185588, PRI Nos. 29834-29838.

Dimensions (mm). —

	height	length
UIMG 560	3.3	4.8
UIMG 561	2.8	3.6
USNM 185587	2.4	3.0
USNM 185588	2.8	3.8

Remarks. — This species is characterized by its small size, the virtually smooth left valve, and the right valves which are sculptured weakly only near the ventral margin. The broad shelf formed by the umbonal-ventral ridge on the left valve is also diagnostic.

The new species differs from *C. togoensis* Oppenheim and *C. atlantica* Furon by its relatively smoother shell, the more abruptly truncated and more convex postero-dorsal margin and the fact that the posterior adductor muscle scar is not located on a raised pad. It may also be readily distinguished from the smooth Togolese species, *C. dactylus* Oppenheim by its stouter, more trigonal shell, the more acutely rounded margins, and the less distinct escutcheon.

Family Uncertain

Unidentified pelecypod Pl. 45, fig. 9

Illustrated specimen. — UIMG No. 577.

Remarks. — A strongly glauconitized cast of an indeterminate pelecypod was collected from the Ewekoro quarry. Though all traces of external features and the hinge were not preserved, the outline is suggestive of the Pholadomyidae. The high glauconite content of the cast suggests derivation from the glauconitic shale bed overlying the Ewekoro Formation.

Unidentified burrow Pl. 10, fig. 7

Illustrated specimen. — UIMG No. 576.

Remarks. — A single, calcified cylindrical burrow was collected from the Ewekoro quarry. It represents infilling of a moderately wide cylindrical tunnel drilled in a relatively firm substrate. The absence of pholads in the fauna recorded here makes identification of the borer impossible, though derivation from a member of that family is not ruled out.

Class CEPHALOPODA Cuvier, 1797

Subclass NAUTILOIDEA Agassiz, 1847

Order NAUTILIDA Agassiz, 1847

Superfamily **NAUTILACEA** de Blainville, 1825

Family **HERCOGLOSSIDAE** Spath, 1927

Genus **CIMOMIA** Conrad, 1866

Cimomia reymenti Adegoke, new species
Pl. 6, figs. 1, 2, 8, 9; Pl. 7, fig. 1; Pl. 8, figs. 1-3, 5

Cimomia landanensis Vincent Reyment, 1965a, pl. 14, figs. 4a, b; 1966d, p. 49, pl. 1, figs. 1a-c (not Vincent, 1913).
Cimomia sp. A, n. sp. Adegoke, 1972a, pl. 1, figs. 1, 2; pl. 2, figs. 2, 13.

Description. — Shell small to large, maximum observed adult height 400 mm, maximum observed thickness of shell 270 mm. Shell height to thickness ratio approximately 2 to 1.

Shell oblong, prolonged anteriorly, with a large final chamber more than ½ whorl in length.

Venter broadly rounded. Umbilicus narrow, blocked by calcareous plug. Septa gently flexed from umbilicus to venter. Siphuncle narrow.

Material. — Over 20 complete and fragmentary specimens.

Types. — Holotype, UIMG No. 118; paratypes, UIMG Nos. 119, 129 and 578 (not figured); USNM No. 182379, PRI No. 29842.

Dimensions (mm). —

	height	maximum thickness
UIMG 118	150.0	190.5
UIMG 119	270.0	180.0
UIMG 129	60.0	40.0
USNM 182379	130.0	65.0

Remarks. — This species may be readily distinguished from other species by its shell height to thickness ratio of about 2 to 1, the gently flexed septa and the final chamber which is more than ½ whorl long.

This is the most abundant nautiloid in the Ewekoro Formation. It forms about 50 percent of the collected nautiloid fauna. The material ranged from immature specimens about 60 mm high to large adults over 400 mm high. The height to thickness ratio was approximately constant thoughout ontogeny (see Text-fig. 7).

Cimomia reymenti has a narrower venter and a longer final chamber than *C. milleri* Adegoke, new species, and *C. ogbei* Adegoke, new species. Its mature form may be readily distinguished from similar size forms of *C. dessauvagiei* Adegoke, new species, by its simpler, gently arched septa.

Cimomia landanensis Vincent (1913) is broader ventrally with lower and wider chambers and a more central siphuncle than the present species.

The new species is similar in outline with *C. sudanensis* Miller and *C. tessieri* Miller. It differs from both by its slightly flexed septa. The species is named in honor of Professor R. A. Reyment of Uppsala who first recorded nautiloids from the Ewekoro quarry.

Cimomia ogbei Adegoke, new species Pl. 9, figs. 1, 2

Description. — Shell moderately large, with a subcircular outline. Shell many-chambered. Final chamber smaller than penultimate chamber.

Venter broadly rounded giving a subspherical shape to the shell. Height to thickness ratio approximately 1. Septa thick, gently sinuous. Siphuncle narrow, slightly eccentric with respect to shell axis, and it is nearer the dorsum.

Material. — One adult and one immature specimen.

Type. — Holotype, UIMG No. 520; paratype (unfigured), USNM No. 182380.

Dimensions (mm). —

	height	maximum thickness
UIMG 520	110	80
USNM 182380	15	20

Remarks. — This species is characterized by its highly septate shell and the extremely broad venter, a feature producing a globular shell with a height to thickness ratio of one or less (see Text-fig. 7). The broad venter, the gently sinuous septa the eccentric siphuncle distinguish it from the other species described here.

The new species, based on two specimens, the holotype and an unfigured immature specimen, is named in honor of Mr. F. G. A. Ogbe.

Cimomia milleri Adegoke, new species

Pl. 7, figs. 2-4; Pl. 10, figs. 1, 8, 9

Cimomia sp. C, n. sp. Adegoke, 1972a, pl. 1, fig. 3.
Cimomia sp. E, n. sp. Adegoke, 1972a, pl. 2, figs. 5, 11..

Descripton. — Shell medium, highly septate. Venter small for the size of the shell, moderately pointed. Shell expands rapidly with final chamber flaring out broadly. Height to thickness ratio about 1 to 1.4 (see Text-fig. 7). Final chamber narrow and low, like preceding chambers.

Septa distinct, sharply flexed near the umbilicus with a broad lobe near the venter. Umbilicus narrow, not closed by a plug. Siphuncle narrow, closer to the dorsum (Pl. 10, fig. 1).

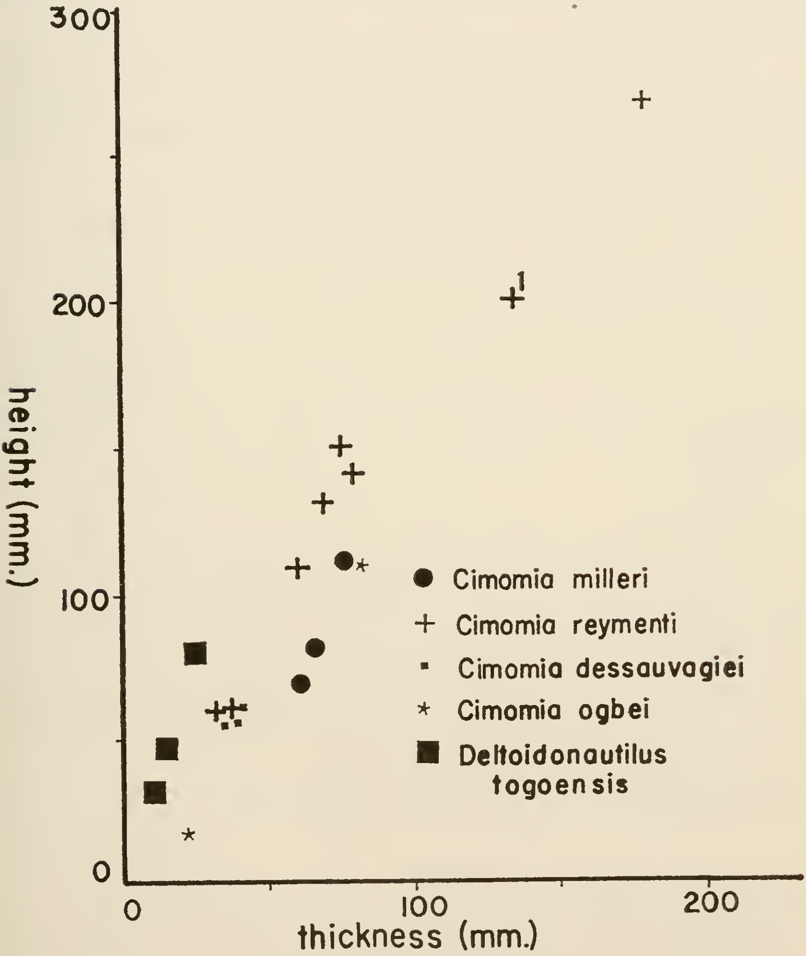
Material. — Four nearly complete specimens.

Types. — Holotype, UIMG No. 132; paratypes, UIMG Nos. 120, 133, USNM No. 185036, PRI No. 29843.

Dimensions (mm). —

	height	maximum thickness
UIMG 132	110	75
UIMG 133	80	65
USNM 185036	70	60

Remarks. — This is one of the most distinctive nautiloids from Ewekoro. It is characterized by the highly septate shell and the flared out nature of the low, final chamber in contrast to the small and narrow venter.



7. Graph showing the relationship of shell height to maximum thickness for some Ewekoro nautiloids. [1]The dimensions of this large specimen is plotted as half of the actual value

Cimomia dessauvagiei Adegoke, new species Pl. 8, figs. 4, 6-10

Cimomia sp. D, n. sp. Adegoke, 1972a, pl. 2, fig. 1; 1973, fig. 12.

Description. — Shell small, maximum adult height 70.0 mm, maximum observed thickness over 50 mm. Height to thickness ratio about three to two. Outline subcirular. Shell highly septate, with small final chamber.

Venter broadly rounded. Aperture moderately flared out, with narrow siphuncle located about ⅓ of the distance, nearer the dorsum (Pl. 8, figs. 8-10). Septa doubly flexed, much like *Hercoglossa*. Umbilicus narrow, not closed by a calcareous plug.

Material. — Four specimens.

Types. — Holotype, UIMG No. 128; paratype, UIMG Nos. 521, 522, USNM 185037.

Dimensions (mm). —

	height	maximum thickness
UIMG 128	60.8	30.2
UIMG 521	—	—
UIMG 522	58	36
USNM 185037	60	40

Remarks. — This species is characterized by its small adult size (see Text-fig. 7), the *Hercoglossa*-like sinuous septa, the highly septate shell with a small final chamber.

Its venter is comparable to that of immature specimens of *C. reymenti* Adegoke, new species, from which it is readily distinguished by the more sinuous septa and the smaller body chamber.

The new species is named in honor of my friend Professor T. F. J. Dessauvagie, I. T. C., Delft, The Netherlands.

Subgenus **AFROCIMOMIA** Adegoke, new subgenus

Diagnosis. Shell moderately large, like *Cimomia*. Venter broadly rounded. Chambers large, average chamber height about 15-20 mm. Septa thrown into a broad, U-fold. Siphuncle large, with an average exterior diameter of about 13 mm.

Type species. — *Cimomia (Afrocimomia) ewekoroensis* Adegoke, new species.

Remarks. — The diagnostic feature of this new subgenus is the large siphuncle. According to Miller (1935, 1951) the genus *Cimomia* is characterized by a narrow siphuncle (compare Pl. 9, figs. 5, 6 with Pl. 7, fig. 1). Apart from the large siphuncle, other morphological characters of the subgenus are *Cimomia*-like, hence it is treated as a subgenus of the latter.

Cimomia (Afrocimomia) ewekoroensis Adegoke, new species
Pl. 9, figs. 5-7

Nautiloid, gen. et sp. nov. Adegoke, 1972a, pl. 1, figs. 10, 11.

Descripton. — Same as for subgenus.

Material. — One fragmentary specimen.

Type. — Holotype, UIMG No. 127.

Remarks. — The new subgenus is represented only by the holotype. Though incomplete, the morphological features of the specimen warrants recognition as a new subgenus. The chambers are higher than in species of *Cimomia s. s.* of comparable size and the siphuncle is more than twice as wide. It is located nearer the venter.

Intense recrystallization of calcite has occurred within the cavity of the chambers (Pl. 9, figs. 5, 6).

Genus **DELTOIDONAUTILUS** Spath, 1927

Deltoidonautilus togoensis Miller Pl. 10, figs. 2-6

Nautilus cf. *Deluchi* d'Arch. Oppenheim, 1915, p. 61, pl. 5, figs. 6a, b.
?*Nautilus* aff. N. *Chudeaui* Douvillé, 1920, p. 141.
Deltoidonautilus sp. Miller, 1935, p. 168.
Deltoidonautilus togoensis Miller, 1951, p. 67, pl. 29, figs. 3, 4; Reyment, 1966d, p. 55; Adegoke, 1972a, pl. 1, fig. 4; pl. 2, figs. 3, 10.

Description. — Shell small to medium-sized, lenticular with an angular bluntly V-shaped venter which is more acute on adult than on young whorls.

Umbilicus small, not closed by calcite plug. Siphuncle moderately wide, located nearer the dorsum. Septa regularly spaced, deeply flexed, with about 15 camerae per half whorl.

Material. — Four nearly complete shells.

Types. — Hypotypes, UIMG Nos. 121, 130, USNM No. 185038.

Dimensions (mm). —

	height	maximum thickness
UIMG 121	81.5	28.5
UIMG 130	33.7	12.4
USNM 185038	—	—

Remarks. — This species is represented in my collection by four almost complete specimens. It may be readily distinguished from *D. senegalensis* (Douvillé) by its more lenticular but smaller size. *D. rogeri* Miller (1951) from Senegal is larger, wider near the umbilical area, and its dorsal impressed zone is smaller than in *D. togoensis*.

D. deluci (d'Archiac) (Vredenburg, 1929, p. 11, pl. 2, figs. 3, 4; pl. 3, figs. 1-4) from the Ranikot of India is larger-sized, with a wider conch, and a more rounded periphery.

Phylum CHORDATA

Class PISCES

Order SQUATINIDA

Suborder RAJOIDEI

Superfamily **MYLIOBATOIDEA**

Family **MYLIOBATIDAE** Müller and Henle, 1837

Genus **RHINOPTERA** Cuvier, 1829

Rhinoptera sp. indet. Pl. 50, figs. 30-35

Illustrated specimens. — UIMG Nos. 573, 574, USNM Nos. 185597, 185598.

Remarks. — Several isolated teeth of the middle and lateral series of this genus were collected from the Ewekoro quarry.

Genus **MYLIOBATIS** Cuvier, 1817

Myliobatis sp. indet. Pl. 50, figs. 24, 25

Illustrated specimens. — UIMG No. 570, USNM No. 185594 (unfigured).

Remarks. — A single complete tooth plate and several fragmentary pieces were collected from the Ewekoro quarry. The complete specimen is strongly convex on the upper surface and concave below.

Order ODONTASPIDIDA

Superfamily **ODONTASPIDOIDEA**

Family **ODONTASPIDIDAE** Müller and Henle, 1839

Subfamily **ODONTASPIDINAE** Müller and Henle, 1839

Genus **ODONTASPIS** Agassiz, 1838

Odontaspis sp. indet. Pl. 50, figs. 26-29

Illustrated specimens.—UIMG Nos. 571, 572, USNM Nos. 185595, 185596. Unfigured specimen. PRI No. 29840.

Remarks.—A few, well-preserved lateral denticles of the anterior teeth of *Odontaspis* were collected. These denticles were more abundant in the red phosphatic biomicrite unit.

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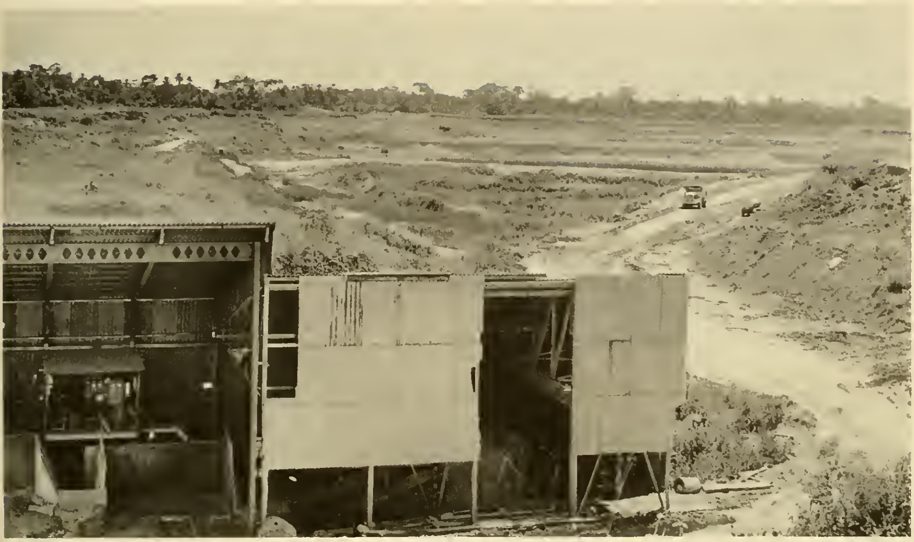
PLATES

EXPLANATION OF PLATE 1

Photos by Mr. R. M. Akinola, West African Portland Cement Company, Lagos, Nigeria.



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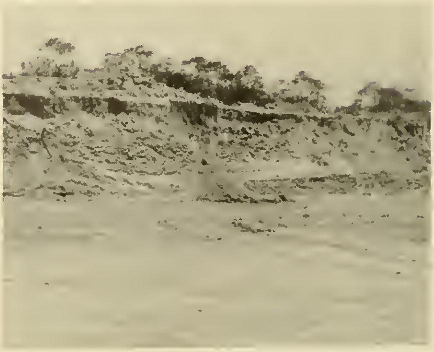

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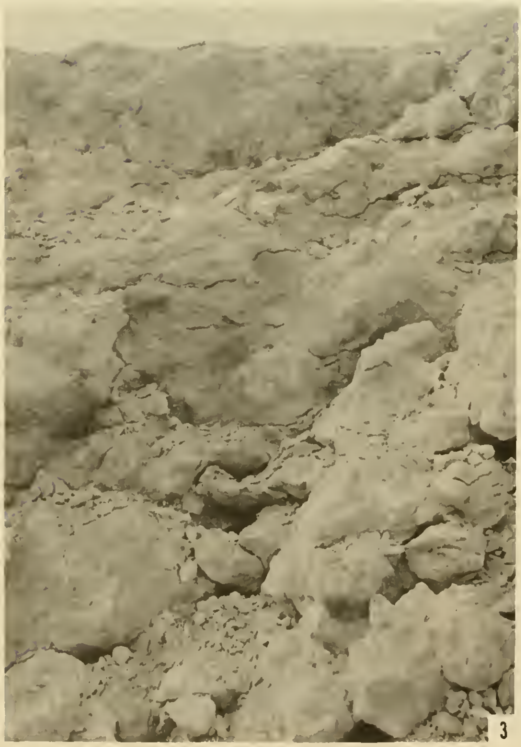

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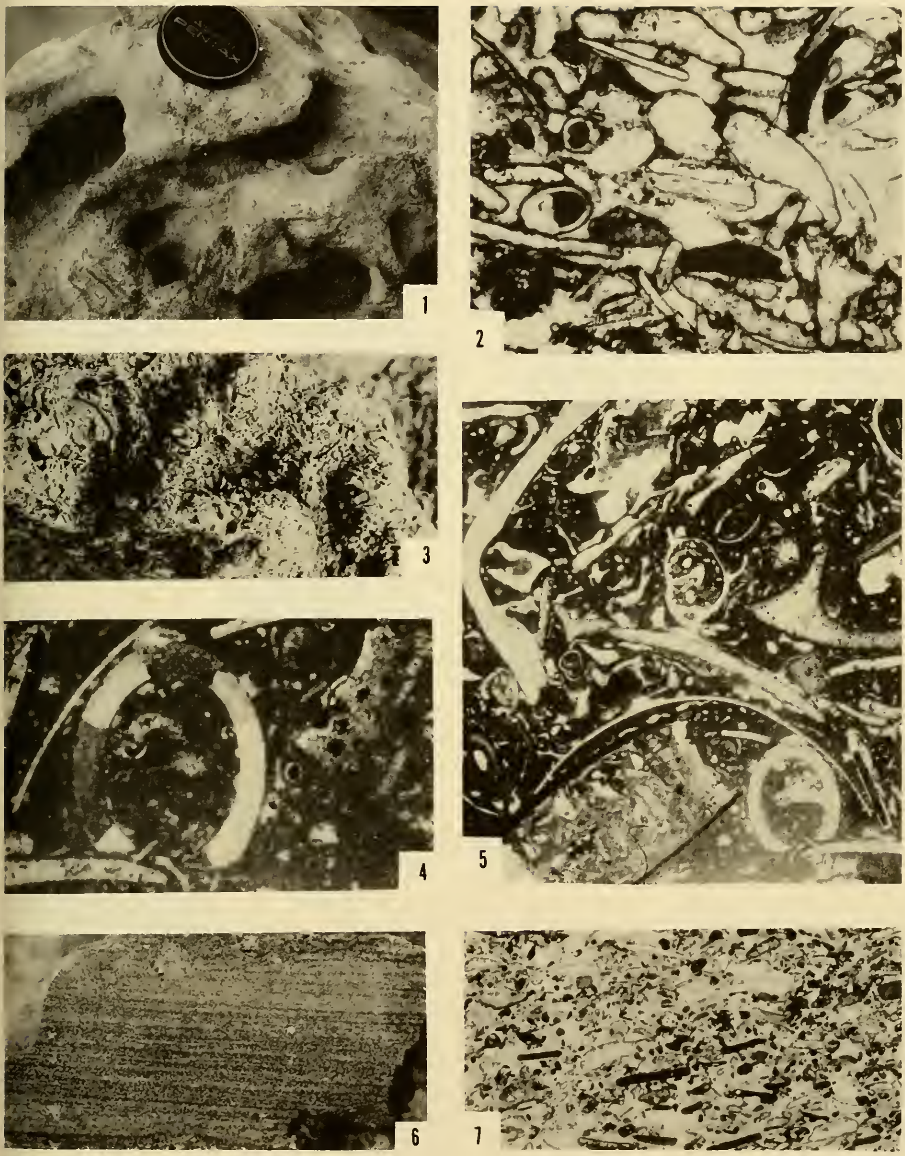
EXPLANATION OF PLATE 2

Photos, Figure 3 by Mr. R. M. Akinola, West African Portland Cement Company, Lagos, all others by the author.

EXPLANATION OF PLATE 3

Figure		Page
1, 2.	Algal biosparite (Unit III) .... 1. Hand specimen showing the deeply potholed and scoured surface; 2. Thin section showing abundant algae in a matrix of sparry calcite. Other allochem include foraminifera and echinoderms.	27
3-5.	Shell biomicrite (Unit II) .... 3. Hand specimen showing the rich bioclastic content of the unit; 4, 5. Thin sections showing intense recrystallization of the bioclastic fragments and the micritic matrix. Note that most allochems have been replaced by drusy calcite.	27
6, 7.	Sandy biomicrosparite (Unit I) .... 6. Polished hand specimen, about 3 inches thick, showing distinct microlayering. The entire specimen itself represents a macrolayer separated from adjacent macrolayers by thin fossiliferous bands. 7. Thin section showing random quartz grains and orientated algal and bioclastic fragments.	27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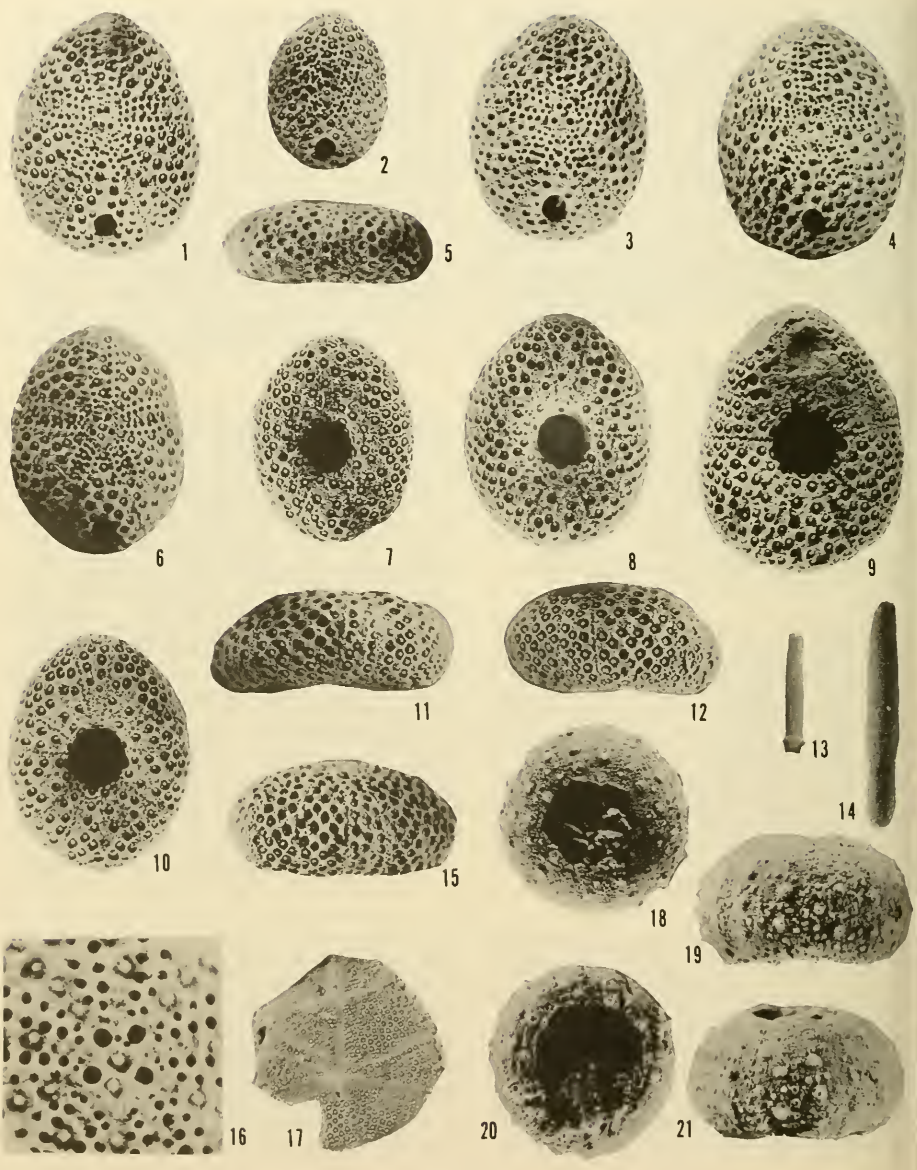
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EXPLANATION OF PLATE 4

Figure		Page
1-12, 15-16.	**Togocyamus seefriedi** Oppenheim	55
	1. Apical view, hypotype, UIMG No. 139, ×6½; 2, 11. Apical and side views, hypotype, UIMG No. 160, ×6½; 3, 15. Apical and side views, hypotype, UIMG No. 161, ×6½; 4, 12. Apical and side views, hypotype, UIMG No. 162, ×6½; 6. Apical view, hypotype, UIMG No. 163, ×6½; 16. Same view greatly enlarged (×20) to show genital pores and non-conjugate ambulacral pores; 5, 7. Side and oral views of hypotype, USNM No. 174756, ×6½; 8. Oral view, hypotype, USNM No. 174757, ×6½; 9. Oral view, hypotype, USNM No. 174758, ×6½; 10. Oral view, hypotype, USNM No. 174759, ×6½.	
13, 14.	Spines of unidentified echinoids	61
	UIMG Nos. 168, 169 respectively, ×6½.	
17.	Unidentified spatangoid fragment	60
	USNM No. 174763, showing food grooves and evenly distributed tubercles, ×2.	
18-21.	**Thylechinus (?Thylechinus) tessieri** Adegoke, new species	60
	Holotype, UIMG No. 166, ×6½; 18. Apical view showing the wide periproct; 19, 21. Side views showing major and secondary tubercles in interambulacral area; 20. Oral view showing wide peristone.	

EXPLANATION OF PLATE 5

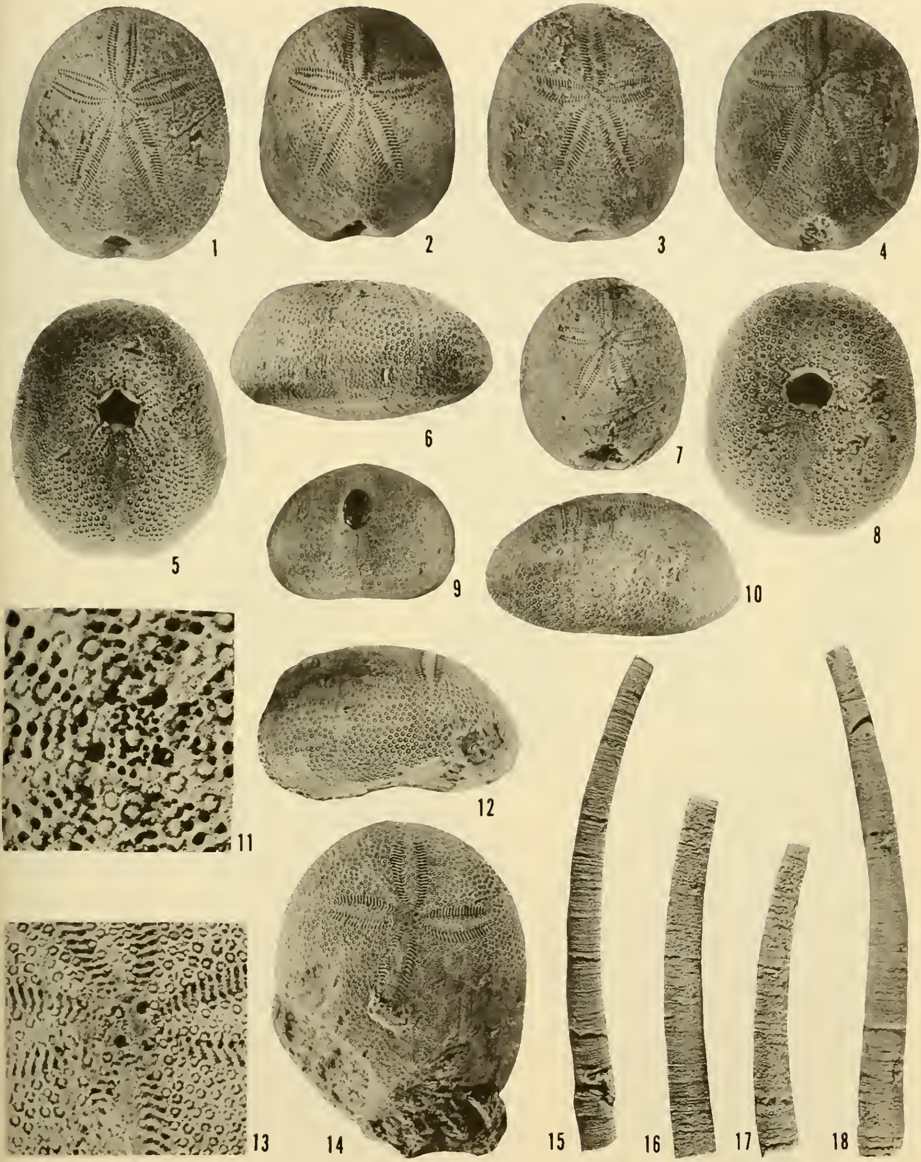
Figure	Page

1-14. Cassidulus kieri Adegoke, new species 58

1, 5, 6, 11. Holotype, UIMG No. 145; 1. Apical view showing elongate petals and the posterior location of the anus, ×2; 5. Oral view showing floscelle, ×2; 6. Side view showing the relatively high test, ×2; 11. Apical view highly magnified (×17) to show gonopores, porous apical plate and the conjugate ambulacral pores; 2. Paratype, UIMG No. 164, apical view, ×2; 3, 9. Paratype, UIMG No. 165, apical and anal views, ×2; 4, 8, 10. Paratype, USNM No. 174760, apical, oral and side views showing subevenly distributed spine bases, ×2; 7. Paratype, USNM No. 174761, apical view, ×2; 12, 13, 14. Paratype, USNM No. 174762, aberrant specimen with four petals; 12. Side view showing high test with evenly distributed spine bases; 14. Apical view; 13. Same view highly enlarged to show gonopores and the conjugate ambulacral pores, ×8.

15-18. Dentalium (Laevidentalium) guineense Adegoke, new species 62

15. Holotype, UIMG No. 176, ×3⅓; 16-18. Paratypes, UIMG No. 177, USNM Nos. 174763, 174764 respectively, ×3⅓.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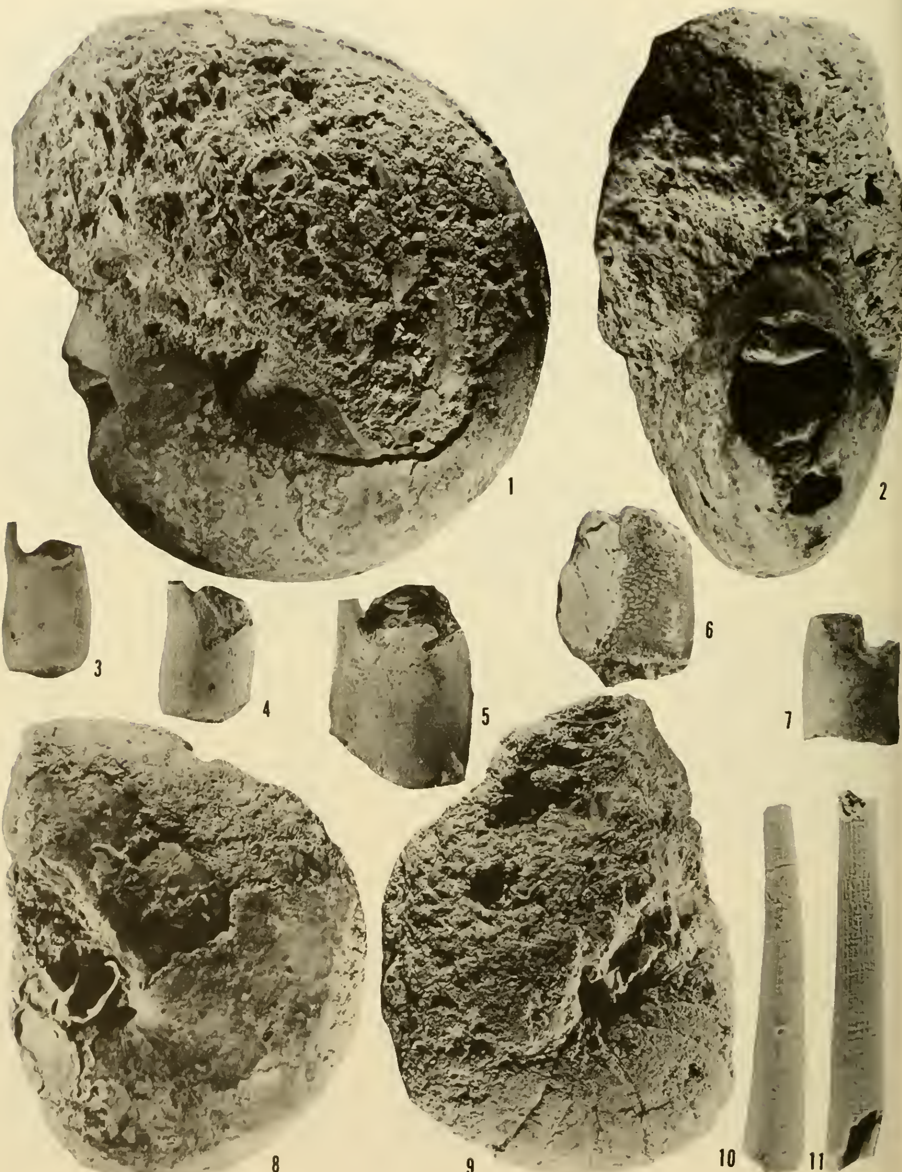
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EXPLANATION OF PLATE 6

Figure		Page
1, 2, 8, 9.	**Cimomia reymenti** Adegoke, new species	292
	1, 2. Umbilical and apertural views of holotype, UIMG No. 118, ×½; 8, 9. Umbilical views of paratype, USNM No. 182379, ×½. Note the simple septa.	
3-7.	**Callianassa seefriedi** von Ammon	62
	Claws of hypotypes, UIMG Nos. 183-185, USNM Nos. 174768, 174769 respectively, ×1.	
10, 11.	**Dentalium (Antalis) ewekoroense** Adegoke, new species	64
	Views of paratype, USNM No. 174767, holotype, UIMG No. 182 respectively, showing the reticulate sculpture, ×6½.	

EXPLANATION OF PLATE 7

Figure | Page

1. **Cimomia reymenti** Adegoke, new species 292

Paratype, UIMG No. 119, view of broken specimen showing a series of septa and narrow siphuncle, ×⅓.

2-4. **Cimomia milleri** Adegoke, new species 294

2, 3. Umbilical and apertural views of holotype, UIMG No. 132, note highly septate nature, small body chamber, and relatively narrow venter, ×½; 4. Umbilical view of paratype, UIMG No. 133, ×½.

5-10. **Dentalium (Laevidentalium) nigeriense** Adegoke, new species 63

5, 10. Holotype, UIMG No. 179, ×1⅓; 6. Paratype, UIMG No. 180, note borings by predatory gastropods, ×3⅓; 7-9. Paratypes, UIMG No. 181, USNM Nos. 174765, 174766, ×1⅓.


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EXPLANATION OF PLATE 8

Figure Page

1-3, 5. **Cimomia reymenti** Adegoke, new species 292

Umbilical, apertural, and ventral views of paratype, UIMG No. 129, note narrow umbilicus, gently sinuous suture, and large body chamber of this young specimen, $\times 2/3$.

4, 6-10. **Cimomia dessauvagiei** Adegoke, new species 296

4, 8. Umbilical and apertural views of paratype, USNM No. 185037, $\times 2/3$; 6, 7. Lateral and venter views of holotype, UIMG No. 128, $\times 2/3$; 10. Apertural view of an immature specimen, UIMG No. 522, enclosed in the cast of *C. reymenti* Adegoke, new species, $\times 1/2$; 9. Side view of an incomplete specimen, paratype, UIMG No. 521 showing narrow venter, $\times 2/3$. Note the double flexure of suture in this species.

EXPLANATION OF PLATE 9

Figure — Page

1, 2. **Cimomia ogbei** Adegoke, new species 293

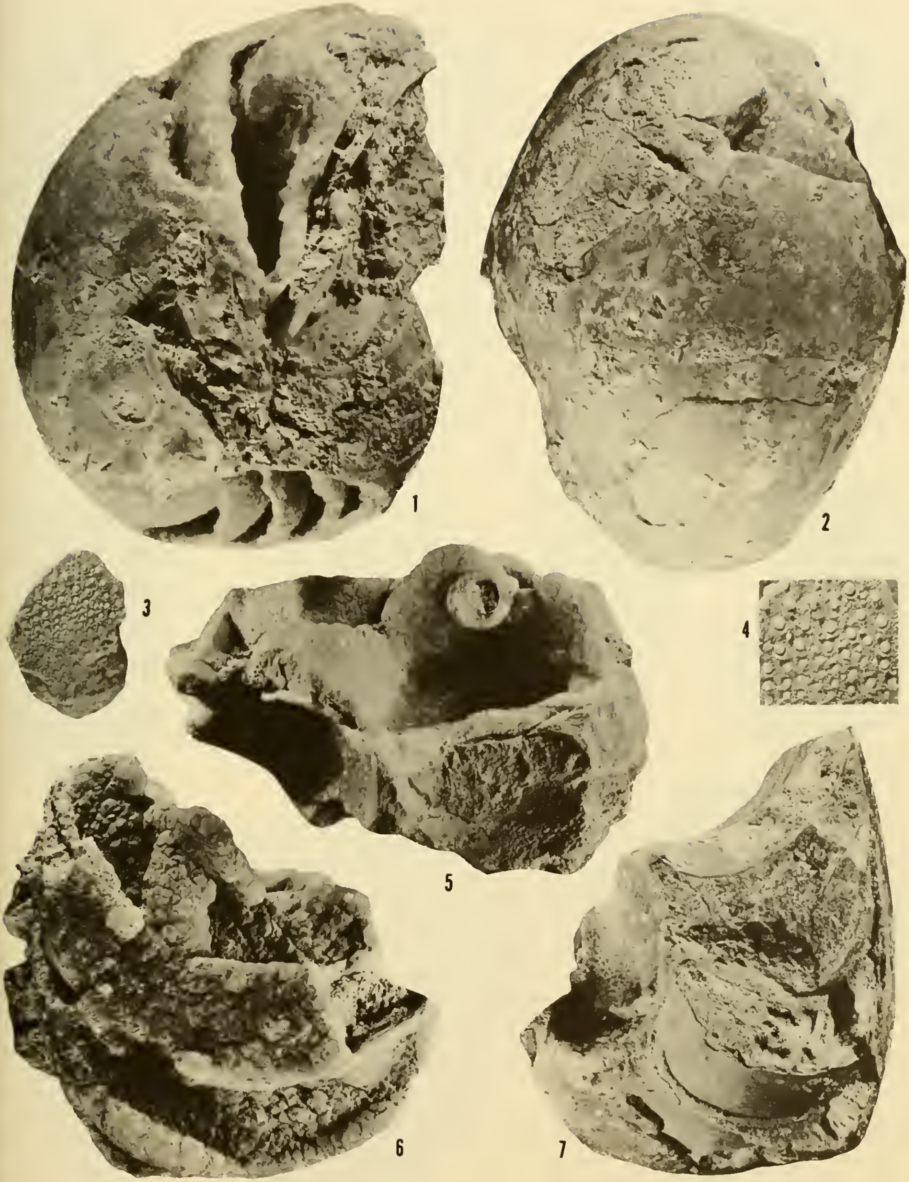
Umbilical and venter views of holotype, UIMG No. 520, $\times 2/3$. Note the broadly rounded venter and thickened, simple septa which are intensely recrystallized.

3, 4. Indeterminate echinoid; illustrated specimen 61

UIMG No. 167, showing two different sizes of spine bases, 3. $\times 3\frac{1}{3}$, 4. $\times 6\frac{1}{2}$.

5-7. **Cimomia (Afrocimomia) ewekoroensis** Adegoke, new subgenus, new species 297

Various views of the incomplete holotype, UIMG No. 127, showing the simple septa with highly recrystallized calcite, and the wide siphuncle, $\times 2/3$.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EXPLANATION OF PLATE 10

Figure		Page
1, 8, 9.	**Cimomia milleri** Adegoke, new species	294
	1, 8. Venter and apertural views of paratype, UIMG No. 133, note highly septate test and narrow siphuncle, ×⅔; 9. Umbilical view of paratype, USNM No. 185036, ×⅔.	
2-6.	**Deltoidonautilus togoensis** Miller	297
	2, 3, 4. Umbilical, apertural and venter views of hypotype, UIMG No. 121, ×⅔; 5. Incomplete specimen, paratype, USNM No. 185038, ×1; 6. Umbilical view of paratype, UIMG No. 130, ×1.	
7.	Unidentified burrow probably belonging to a pholad	292
	Illustrated specimen, UIMG No. 576, ×⅔.	
10.	?Crinoid stem fragment	61
	Illustrated specimen, UIMG No. 178, ×6½.	

EXPLANATION OF PLATE 11

Figure | Page

1, 2. **Fissurella nigeriensis** Adegoke, new species 65
Two views of the holotype, UIMG No. 176, ×5 and ×6½ respectively.

3, 7. **Velates nigeriensis** Adegoke, new species 66
3-5. Apical, side and ventral views of holotype, USNM No. 174740, ×⅔; 6. Apertural view of paratype, UIMG No. 141, ×⅔; 7. Lateral view of paratype, UIMG No. 187 showing heavy posterior callosity, ×⅔.

8, 9. **Tectus africanus** Adegoke, new species 67
Abapertural and apertural views of holotype, UIMG No. 188, ×1.

10-15. **Afrollonia nigeriensis** Adegoke, new genus, new species 68
10. Apertural view of holotype, UIMG No. 189, ×5; 11. Abapertural view of paratype, UIMG No. 190, ×5; 12. Umbilical view of paratype, UIMG No. 191, ×5; 13-15. Apical, abapertural and umbilical views of paratypes, USNM Nos. 174741-174743 respectively, ×5.

16-20. **Afrollonia togoensis** Adegoke, new genus, new species 69
16, 17. Apertural and umbilical views of paratype, USNM No. 174744, ×5; 18, 19. Apertural and abapertural views of paratype, UIMG No. 192, note three prominent carinate spirals, ×5; 20. Umbilical view of paratype, UIMG No. 193, ×6½.


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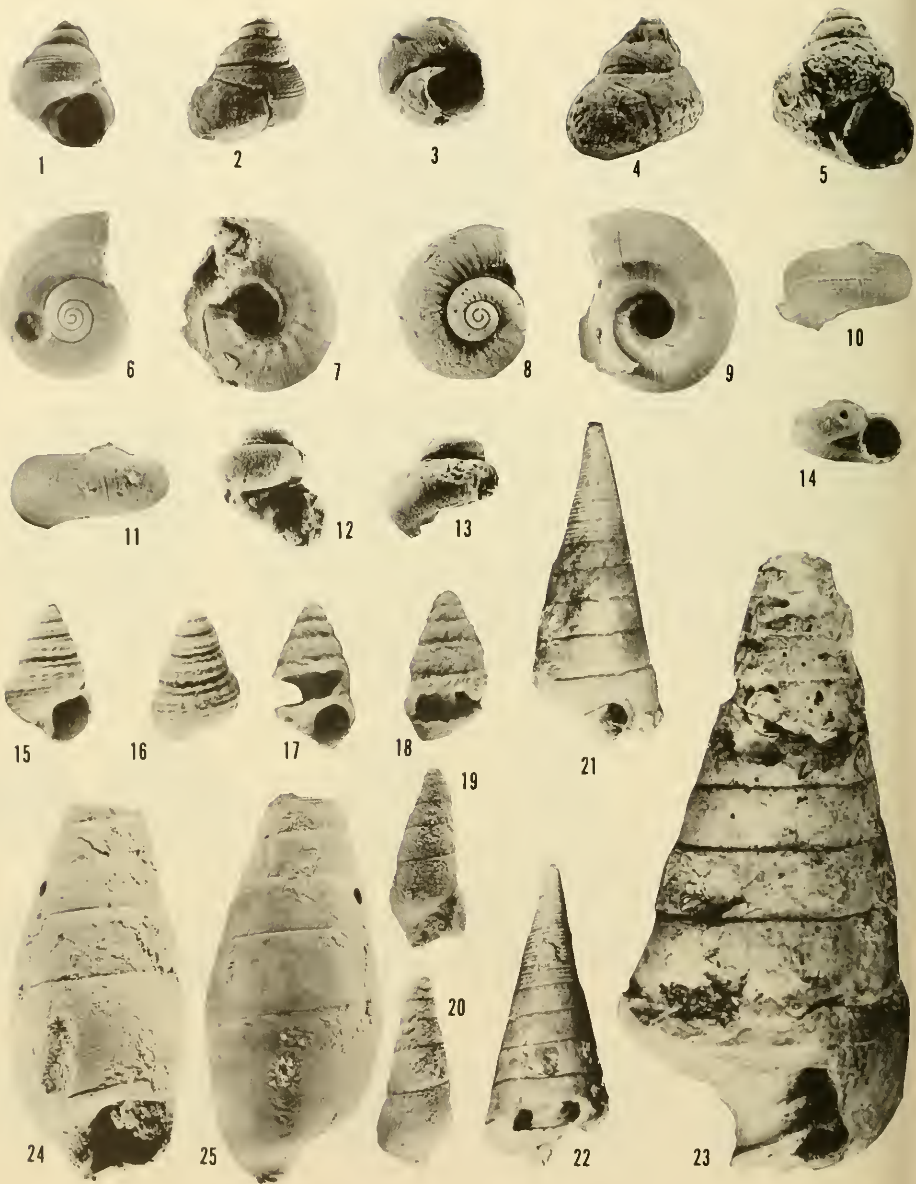
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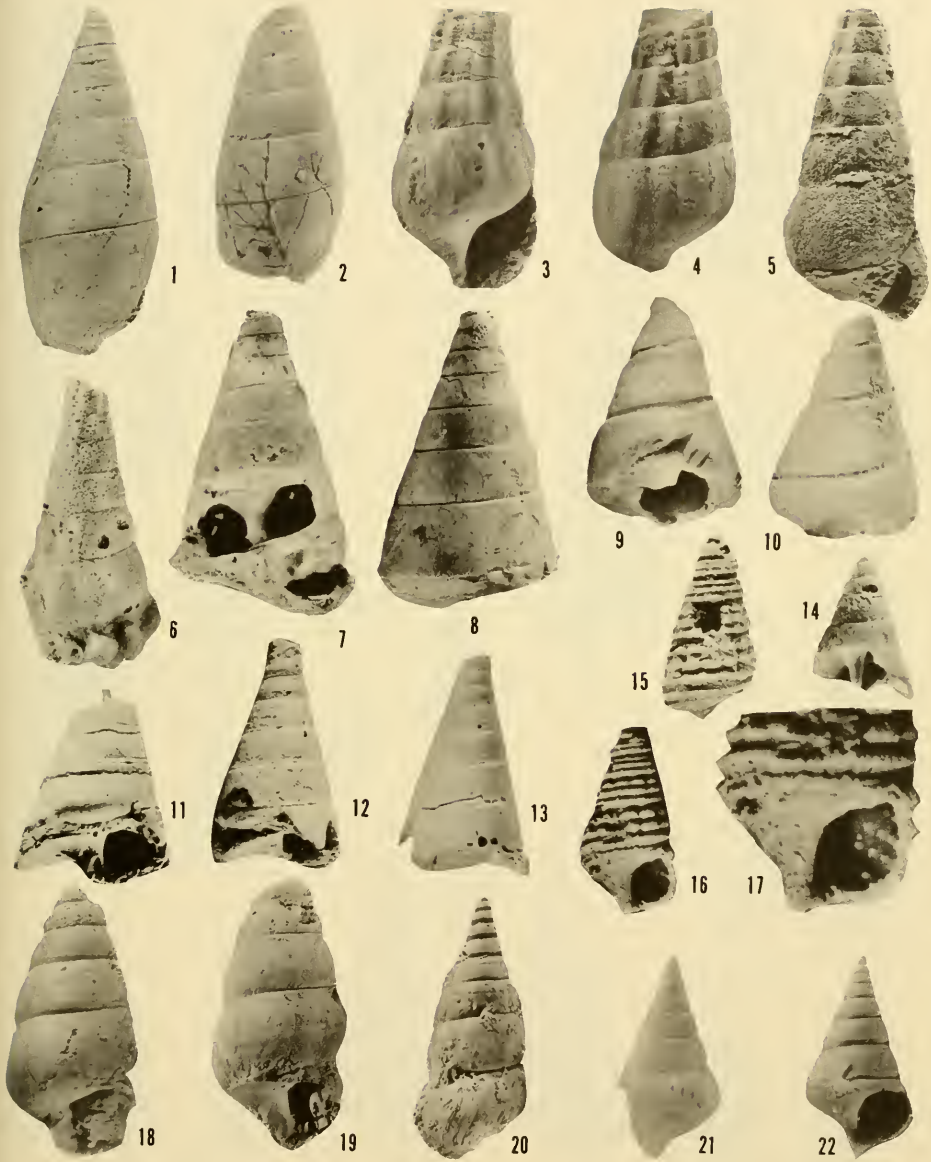
EXPLANATION OF PLATE 12

Figure		Page
1-5.	**Afrollonia angustiumbilicata** Adegoke, new genus, new species	70
	1-3. Apertural, abapertural, and umbilical views of holotype, UIMG No. 194, ×3⅓; 4, 5. Abapertural and apertural views of paratype, USNM No. 174745, ×3⅓.	
6-11, 14.	**Solariella adedayoi** Adegoke, new species	71
	6, 11. Apical and lateral views of holotype, UIMG No. 195, ×6½; 7. Umbilical view of paratype, UIMG No. 196, ×6½; 8. Apical view of paratype, UIMG No. 197, ×6½; 9. Umbilical view of paratype, USNM No. 174746, ×6½; 10. Side view of paratype, USNM No. 174747, ×6½, note the prominent spiral sculpture of this specimen; 14. Aperture view of paratype, USNM No. 174748, ×6½.	
12, 13.	**Norrisia (Norrisella) aurilitoralis** Cox	72
	Apertural and abapertural views of hypotype, UIMG No. 198, ×5.	
15-18.	**Mirachelus adeyemoi** Adegoke, new species	73
	15, 16. Apertural and abapertural views of holotype, UIMG No. 199, ×10; 17, 18. Same views of paratype, USNM No. 174749, ×10.	
19, 20.	**Rissoina nigeriensis** Adegoke, new species	74
	Apertural and abapertural views of holotpye, UIMG No. 200, ×6½. Note the fine axial striae.	
21-23.	**Campanile nigeriense** Adegoke and Dessauvagie	75
	21, 22. Apertural and abapertural views of holotype, UIMG No. 19, ×⅔; 23. Apertural view of paratype, UIMG No. 21, ×⅔.	
24, 25.	**Wendella nigeriensis** Adegoke, new genus, new species	77
	Apertural and abapertural views of holotype, UIMG No. 204, ×1.	

EXPLANATION OF PLATE 13

Figure		Page
1, 2.	**Wendella nigeriensis** Adegoke, new genus, new species 1. Abapertural view of paratype, USNM No. 174752, ×1, note sinuous growth lines; 2. Abapertural view of paratype, UIMG No. 205, ×1.	**77**
3-6.	**Cerithium (Nigerithium) coorayi** Adegoke, new subgenus, new species. .... 3, 4. Apertural and abapertural views of holotype, UIMG No. 206, ×1⅓; 5, 6. Same views of paratype, USNM No. 185035, ×1.	**78**
7-14.	**Druidwilsonia nigeriana** Adegoke, new genus, new species .... 7, 8. Apertural and abapertural views of holotype, UIMG No. 208, ×1⅓, note simple, flexed growth lines; 9, 10. Same views of paratype, UIMG No. 209, ×2; 11. Apertural view of paratype, USNM No. 174753, ×2; 12, 13. Apertural and abapertural views of paratype, USNM No. 174754, ×2; 14. Apertural view of paratype, USNM No. 174755, ×3⅓.	**80**
15-17.	**Bittium guineense** Adegoke, new species .... 15, 16. Abapertural and apertural views of holotype, UIMG No. 210, ×10; 17. Anterior end highly magnified to show labral denticles, ×20.	**80**
18-22.	**Mesalia fallockensis** Tessier **ewekoroensis** Adegoke, new subspecies .... 18. Apertural view of holotype, UIMG No. 136, ×⅔; 19. Apertural view of paratype, USNM No. 174756, ×⅔; 20. Abapertural view of paratype, USNM No. 174757, ×⅔, note the prominent growth lines and the irregular increase in diameter of gerontic whorls; 21, 22. Abapertural and apertural views of paratype, UIMG No. 137, ×1.	**83**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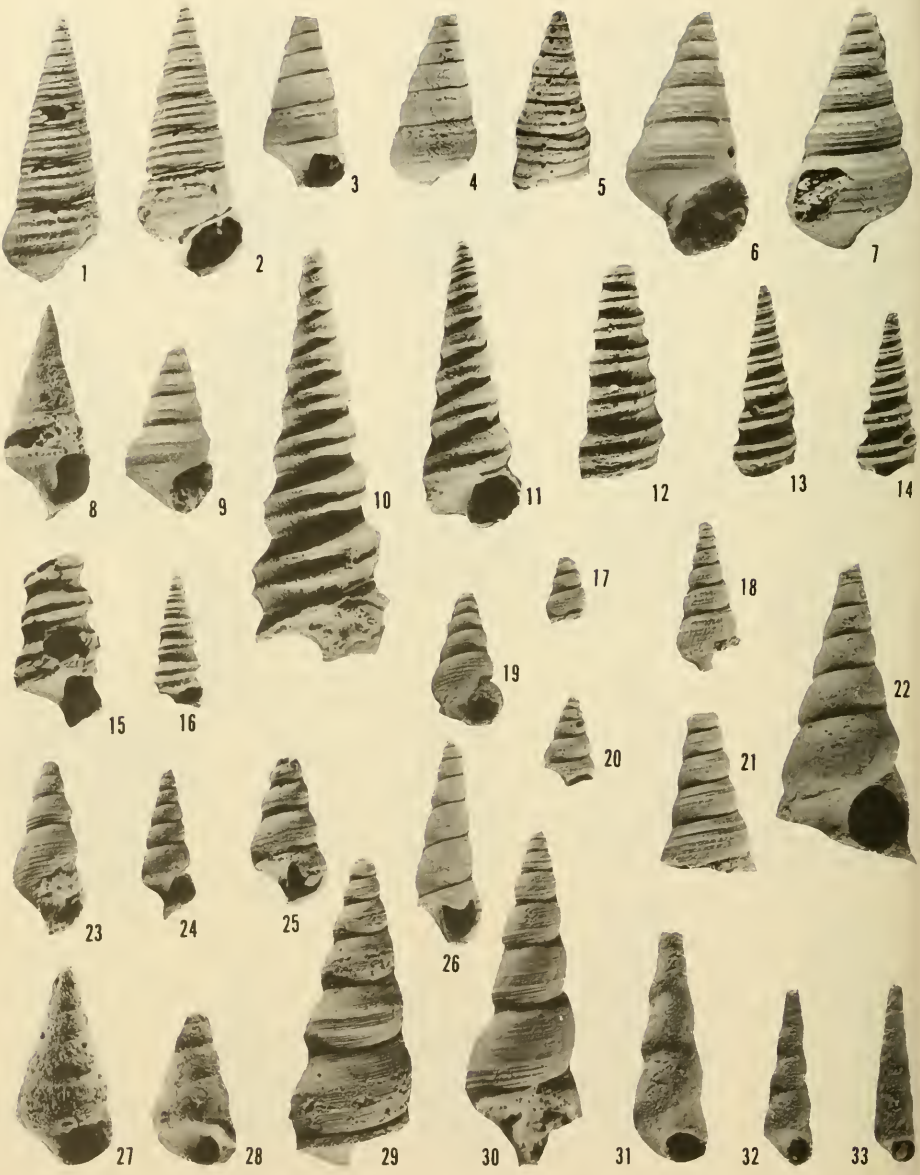
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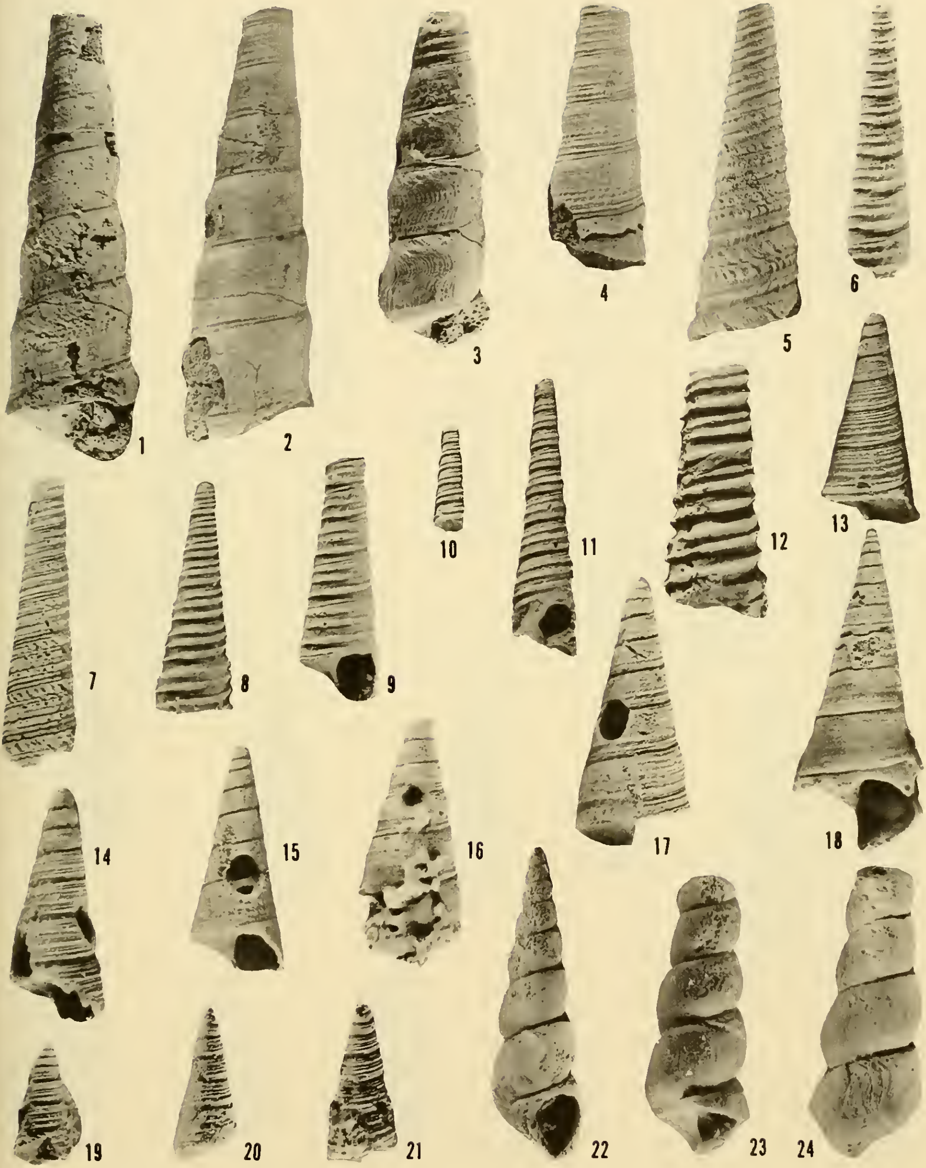
EXPLANATION OF PLATE 14

Figure		Page
1-5.	**Mesalia passi** Adegoke, new species	84
	1, 2. Holotype, UIMG No. 212, ×1⅓; 3, 4. Paratype, USNM No. 174758, apertural view, ×1⅓, abapertural view, ×1½; 5. Abapertural view of paratype, UIMG No. 213, ×1⅓.	
6-9.	**Mesalia rogersi** Adegoke, new species	85
	6, 7. Apertural and abapertural views of holotype, UIMG No. 214, ×1⅓; 8, 9. Apertural views of paratypes, USNM Nos. 174759 and 174760 respectively, ×1⅓.	
10-16.	**Mesalia salvani** Adegoke, new species	86
	10. Apertural view of holotype, UIMG No. 215, ×6½; 11-16. Views of paratypes, UIMG Nos. 216-218, USNM Nos. 174761-174763, ×6½. Note the bicarinate sculpture in which only spirals B and C are developed.	
17, 19, 20, 22.	**Mesalia reymenti** Adegoke, new species	88
	17. Paratype, UIMG No. 220, ×5; 19. Holotype, UIMG No. 219, ×5; 20, 22. Paratypes, USNM Nos. 174764 and 174765, ×5	
18, 21.	**Potamides trituberculatus** Cox	112
	18. Hypotype, UIMG No. 262, ×5; 21. Hypotype, USNM No. 174795, ×5.	
23-25.	**Mesalia akinolae** Adegoke, new species	89
	23. Apertural view of holotype, UIMG No. 412, ×5; 24. Paratype, UIMG No. 413, ×5; 25. Paratype, USNM No. 174894, ×5.	
26, 29, 30.	**Mesalia akinkugbei** Adegoke, new species	89
	26. Apertural view of holotype, UIMG No. 410, ×2⅔; 29. Abapertural view of paratype, UIMG No. 411, ×3⅓; 30. Apertural view of paratype, USNM 174893, ×5. Note elongate whorls and the uneven spiral threads.	
27, 28.	**Mesalia** sp. A	90
	Apertural views of illustrated specimens, UIMG No. 221, ×3⅓ and USNM No. 174766, ×5.	
31-33.	**Mesalia** sp. B	90
	Apertural views of illustrated specimens, UIMG Nos. 222, 223; USNM No. 174767, ×3⅓.	

EXPLANATION OF PLATE 15

Figure		Page
1-4.	**Torquesia adabionensis** (Oppenheim)	91
	1, 2. Hypotype, UIMG No. 134, ×1; 3. Hypotype, USNM No. 174768, ×1, note small aperture; 4. Hypotype, UIMG No. 225, ×1. Note typical nature of the growth lines, straight whorls, and subdued spiral sculpture.	
5-12.	**Torquesia oppenheimi** Adegoke, new species	92
	5. Abapertural view of holotype, UIMG No. 226, ×1⅓; 7-9, 11. Paratypes, USNM Nos. 174769-174772, ×1⅓; 6. Paratype, UIMG No. 227, ×1⅓; 10. Paratype, UIMG No. 228, ×5; 12. Paratype, UIMG No. 229, ×1⅓.	
13-21.	**Reymentella olaniyani** Adegoke, new genus, new species	99
	13. Apertural view of holotype. UIMG No. 238, ×6½; 14, 15, 19. Paratypes, UIMG Nos. 239-241, 14, 15. ×6½; 19. ×5; 16-18, 20, 21. Paratypes, USNM Nos. 174780-174783, ×6½, except figure 18, ×3⅓.	
22-24.	**Haustator furoni** Adegoke, new species	94
	22. Apertural view of holotype, UIMG No. 230, ×2. Note sinuous growth lines; 23, 24. Apertural and abapertural views of paratype, USNM No. 174773, ×2.	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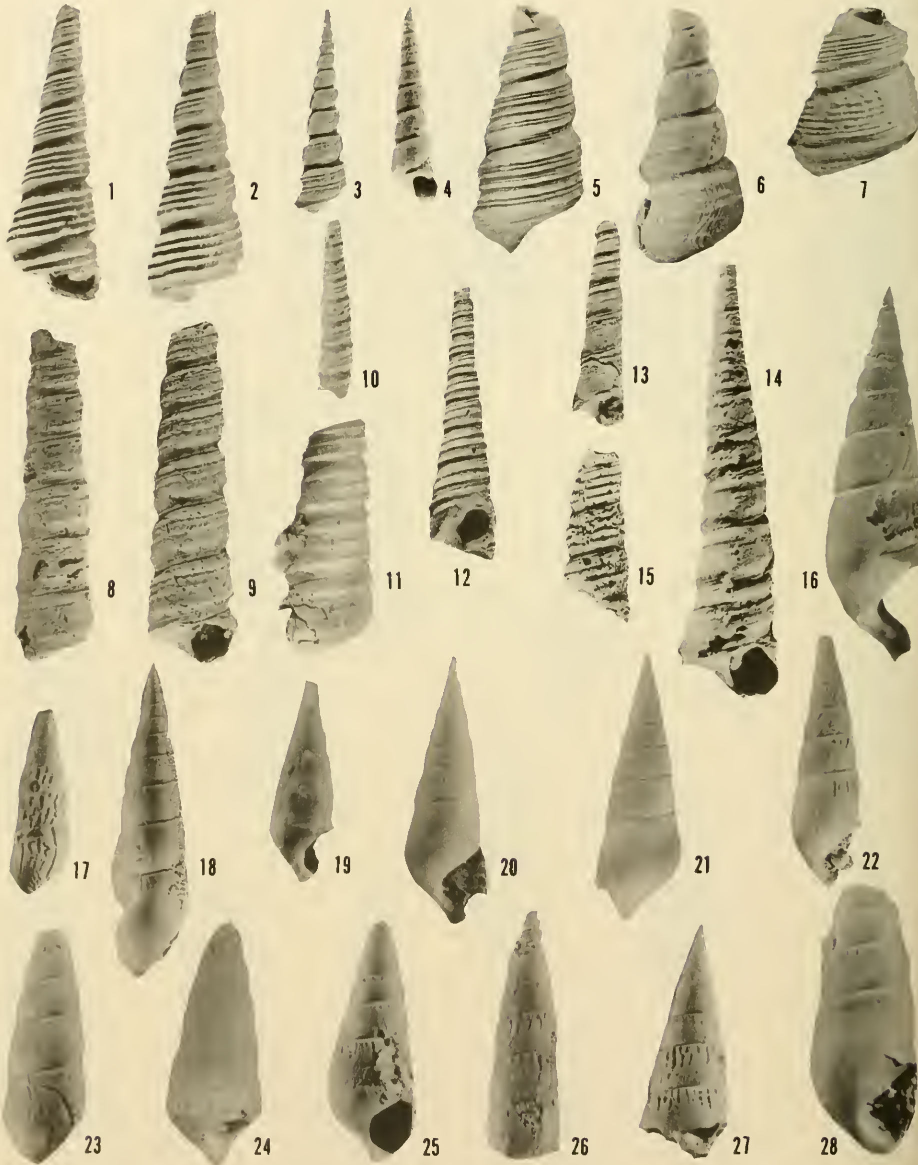
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Explanation of Plate 16

Figure		Page
1-7.	**Haustator nigeriensis** Adegoke, new species	95
	1, 2. Apertural and abapertural views of holotype, UIMG No. 135, ×1⅓; 3-7. Various views of paratypes, UIMG Nos. 232, 233, USNM Nos. 174774-174776, ×1⅓, note the deeply sinuous growth lines.	
8-14.	**Haustator oyawoyei** Adegoke, new species	96
	8, 9. Abapertural and apertural views of holotype, UIMG No. 234, ×3⅓; 10-14. Paratypes, UIMG No. 235, USNM No. 174777, UIMG No. 236, USNM Nos. 174778, 174779 respectively, all ×1⅓ except figure 10 which is ×3⅓.	
15.	**Haustator**, n. sp.	98
	Illustrated specimen, UIMG No. 237, ×1⅓.	
16-22.	**Ewekoroia nigeriensis** Adegoke, new genus, new species	102
	16. Apertural view of holotype, UIMG No. 242, ×2; 17-19. Paratypes, UIMG Nos. 243-245, ×1; 20, 21. Paratype, USNM No. 174784, ×1; 22. Paratype, USNM No. 174785, ×1.	
23-28.	**Ewekoroia acirsoides** (Furon)	103
	Paratypes, UIMG Nos. 246-249, USNM Nos. 174786, 174787, ×1⅓. Note stumpy form and tendency for the growth lines to form rugae in the adapical portions of whorls.	

Explanation of Plate 17

Figure		Page
1-3.	**Ewekoroia rugifera** Adegoke, new genus, new species ..	104
	1. Aperture view of holotype, UIMG No. 250, $\times 1\frac{1}{3}$; 2, 3. Paratype, USNM No. 174788, $\times 1\frac{1}{3}$.	
4-9.	**"Burtinella" ewekoroensis** Adegoke, new species	106
	4-6. Paratype, USNM No. 174791, $\times 6\frac{1}{2}$; 7-9. Holotype, UIMG No. 254, $\times 6\frac{1}{2}$, note the wide umbilicus few whorls.	
10-12.	**"Burtinella" turriformis** Adegoke, new species	106
	Holotype, UIMG No. 255, $\times 6\frac{1}{2}$.	
13-17.	**Vermetus (Vermetus) nigeriensis** Adegoke, new species	105
	13, 15, 17. Paratypes, UIMG Nos. 252, 253, USNM Nos. 174789, 174790; 13, 16, 17, $\times 6\frac{1}{2}$; 15. $\times 3\frac{1}{3}$; 14. Holotype, UIMG No. 251, hand specimen with several individuals, $\times 1\frac{1}{3}$.	
18-20, 25.	**Cerithiopsis (Cerithiopsis) adekunbii** Adegoke, new species	108
	18, 19. Paratype, USNM No. 174793, $\times 6\frac{1}{2}$; 20, 25. Holotype, UIMG No. 257, $\times 6\frac{1}{2}$.	
21-24.	**Cerithiella (Stilus) nigeriensis** Adegoke, new species	107
	21, 22. Apertural and abapertural views of holotype, UIMG No. 256, $\times 10$; 23, 24. Paratype, USNM No. 174792, $\times 10$.	
26, 27.	**Cerithiopsis (Cerithiopsis) fagadei** Adegoke, new species	109
	Holotype, UIMG No. 258, $\times 6\frac{1}{2}$.	
28, 29.	**Cerithiopsis (?Cerithiopsis) akinjidei** Adegoke, new species	110
	Holotype, UIMG No. 259, $\times 3\frac{1}{3}$.	
30, 31.	**Cerithiopsis (Cerithiopsida) yoloyei** Adegoke, new species.	110
	Holotype, UIMG No. 260, $\times 6\frac{1}{2}$.	


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Explanation of Plate 18

Figure		Page
1-4.	**Pyrazus nigeriensis** Adegoke, new species .... 1, 2. Holotype, UIMG No. 261, ×⅔; 3, 4. Paratype, USNM No. 174794, ×1.	111
5, 6, 11, 12.	**Potamides trituberculatus** Cox .... Hypotypes, UIMG Nos. 263, 264, USNM Nos. 174796, 174797, ×3⅓.	112
7-10, 13.	**Planaxis africana** Adegoke, new species .... 7. Holotype, UIMG No. 265, ×10; 8-10, 13. Paratypes, UIMG Nos. 266, 267, USNM Nos. 174798, 174799, ×10.	113
14-16.	**Pseudomalaxis (Nigerialaxis) fayosei** Adegoke, new subgenus, new species .... Apical, apertural, and umbilical views of holotype, UIMG No. 147, ×2.	115
17-19.	**Pseudomalaxis (Nigerialaxis) kayodei** Adegoke, new subgenus, new species .... 17. Paratype, USNM No. 174800, umbilical view, ×6½; 18, 19. Apical and apertural views of holotype, UIMG No. 268, ×6½, note highly inflated protoconch.	116
20.	**Pseudomalaxis (Ewekorolaxis) ewekoroensis** Adegoke, new subgenus, new species .... Paratype, USNM No. 174803, ×6½.	119
21-24.	**Pseudomalaxis (Nigerialaxis) parisoti** Furon .... 21, 22. Apical and umbilical views of hypotype, UIMG No. 269, ×6½; 23, 24. Same views of hypotype, USNM No. 174801, ×6½.	117
25-29.	**Pseudomalaxis (Nigerialaxis) africana** Adegoke, new subgenus, new species .... 25. Apical view, paratype, UIMG No. 271, ×10; note the depressed apex; 26, 27. Apical and umbilical views of holotype, UIMG No. 270, ×10; 28, 29. Apical and apertural views of paratype, USNM No. 174802, ×10.	118
30, 31.	**Pseudomalaxis (Nigerialaxis)** sp. A .... Illustrated specimen, UIMG No. 272, apical and umbilical views, ×6½.	119

EXPLANATION OF PLATE 19

Figure Page

1-6. **Pseudomalaxis (Ewekorolaxis) ewekoroensis** Adegoke, new subgenus, new species 119

1, 2. Apical and umbilical views of holotype, UIMG No. 273, ×10; 3, 4. Apertural and umbilical views of paratype, UIMG No. 274, ×10; 5, 6. Apical and apertural views of paratype, USNM No. 174804, ×10, note rounded outline, sculpture consisting of concentric threads only, and bulbous nuclear whorls.

7-12. **Pseudomalaxis (Platylaxis) nigeriensis** Adegoke, new subgenus, new species 120

7. Umbilical view of holotype, UIMG No. 275, ×6½; 8. Paratype, UIMG No. 276, ×6½, note coarse umbilical nodes; 9, 10. Umbilical and side views of paratype, UIMG No. 277, ×6½; 11, 12. Apical views of paratypes, USNM Nos. 175805, 175806, ×6½.

13-15. **Architectonica asseezi** Adegoke, new species 121

13, 14. Apical and apertural views of holotype, UIMG No. 278, ×1⅓; 15. Umbilical view of paratype, USNM No. 174807, ×1⅓.

16-20. **Architectonica nigeriensis** Adegoke, new species 122

16-18. Apical, apertural, and umbilical views of holotype, UIMG No. 279, ×1⅓; 19, 20. Apical and apertural views of paratype, USNM No. 174808, ×1⅓.

21. **Architectonica** sp. A 123

Illustrated specimen, UIMG No. 280, apical view of fragmentary specimen, ×6½.

22, 23. **Tibia? bivarica** Adegoke, new species 133

Apertural and abapertural views of holotype, UIMG No. 300, ×5⅓, note epitoniid-like axial costae, two discontinuous varices, and typical strombid aperture and columella.

24-28. **Odostomia nigeriensis** Adegoke, new species 123

24, 25. Paratypes, UIMG Nos. 281 and 282, ×6½; 26. Apertural view of holotype, UIMG No. 283, ×6½, note prominent columellar plication; 27, 28. Paratypes, USNM Nos. 174809, 174810, ×6½.

29, 30. **Odostomia? (Ravnostomia) rosenkrantzi** Adegoke, new subgenus, new species 125

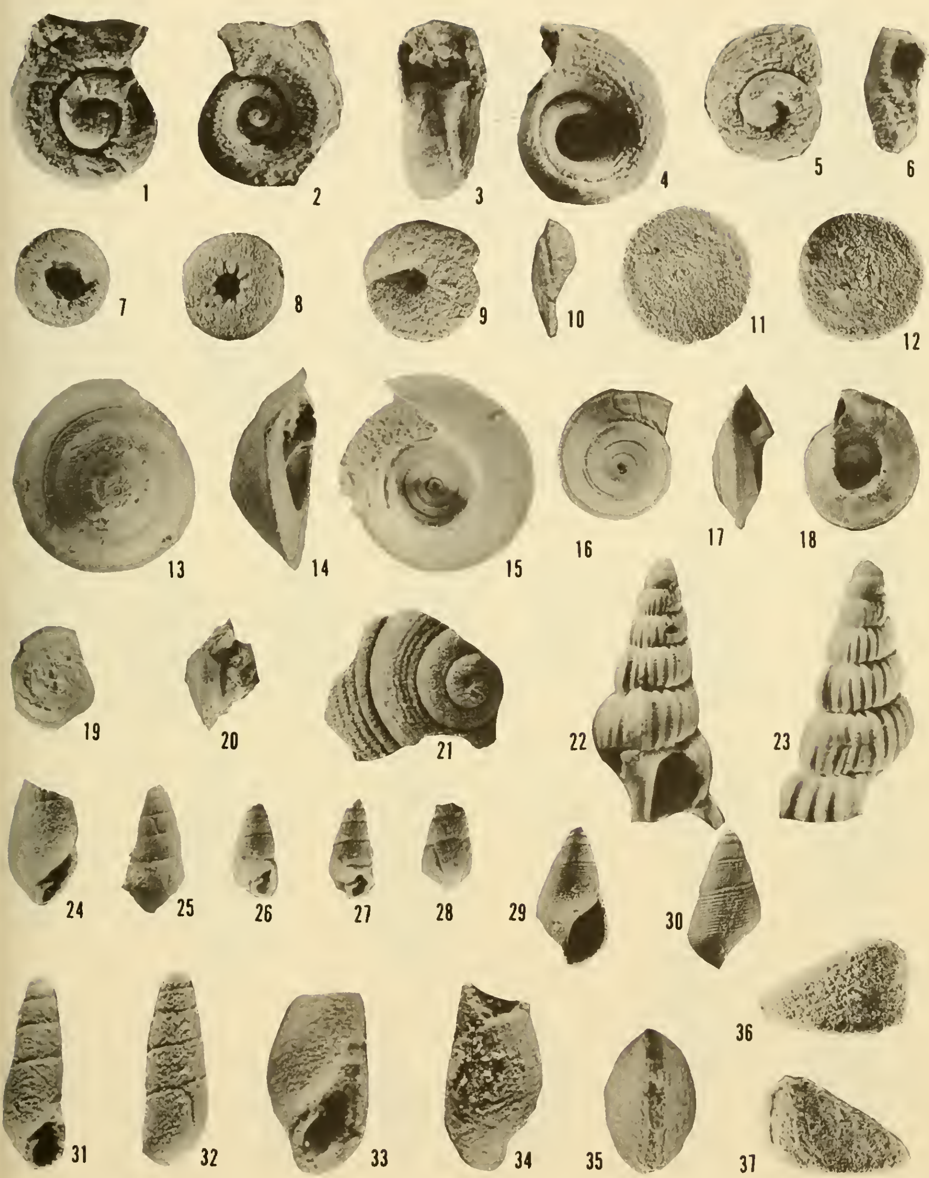
Apertural and abapertural views of holotype, UIMG No. 284, ×6½.

31-34. **Syrnola isiakae** Adegoke, new species 125

31, 32. Apertural and abapertural views of holotype, No. 285, ×10, note the prominent columellar plication; 33, 34. Paratype, USNM No. 174811, ×10.

35-37. **Hipponix** sp. aff. **H. demissus** Cox 126

Apical and lateral views of hypotype, UIMG No. 286, ×6½.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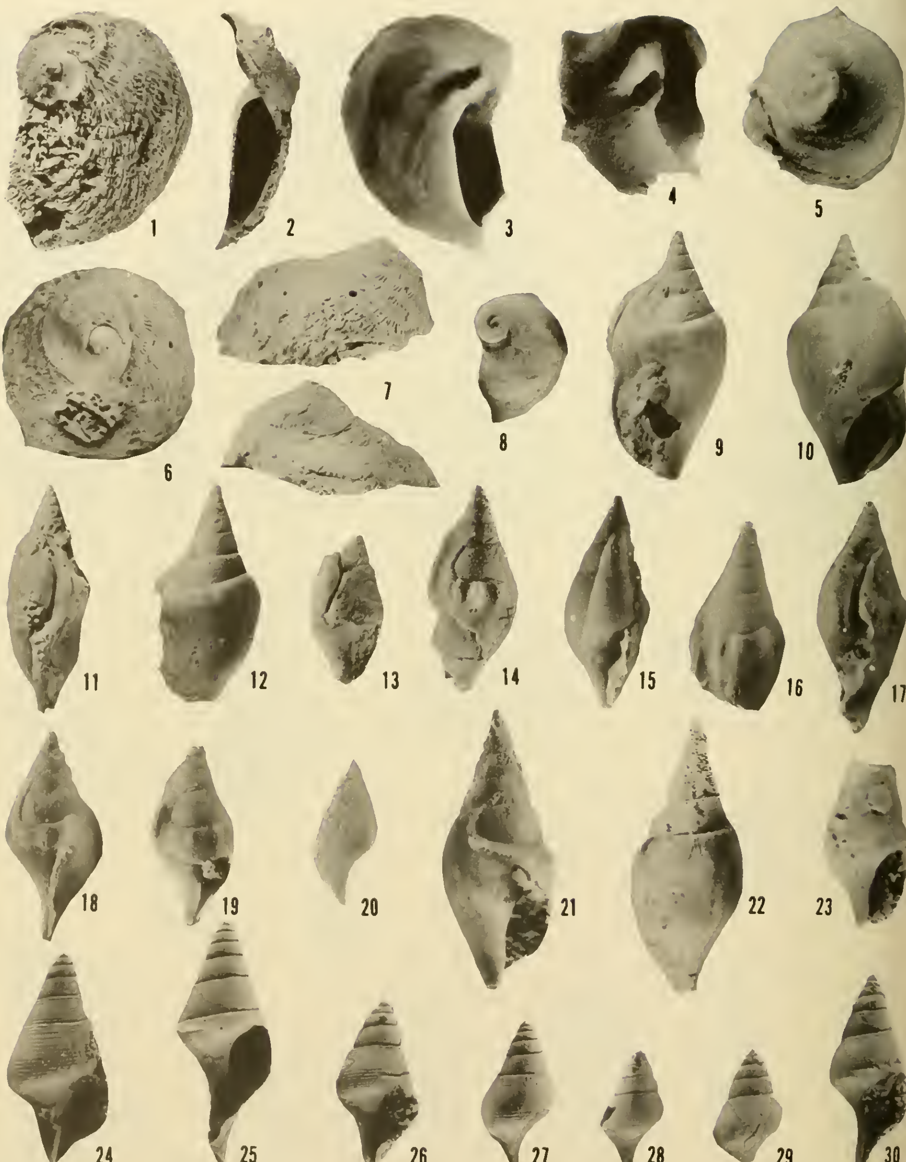
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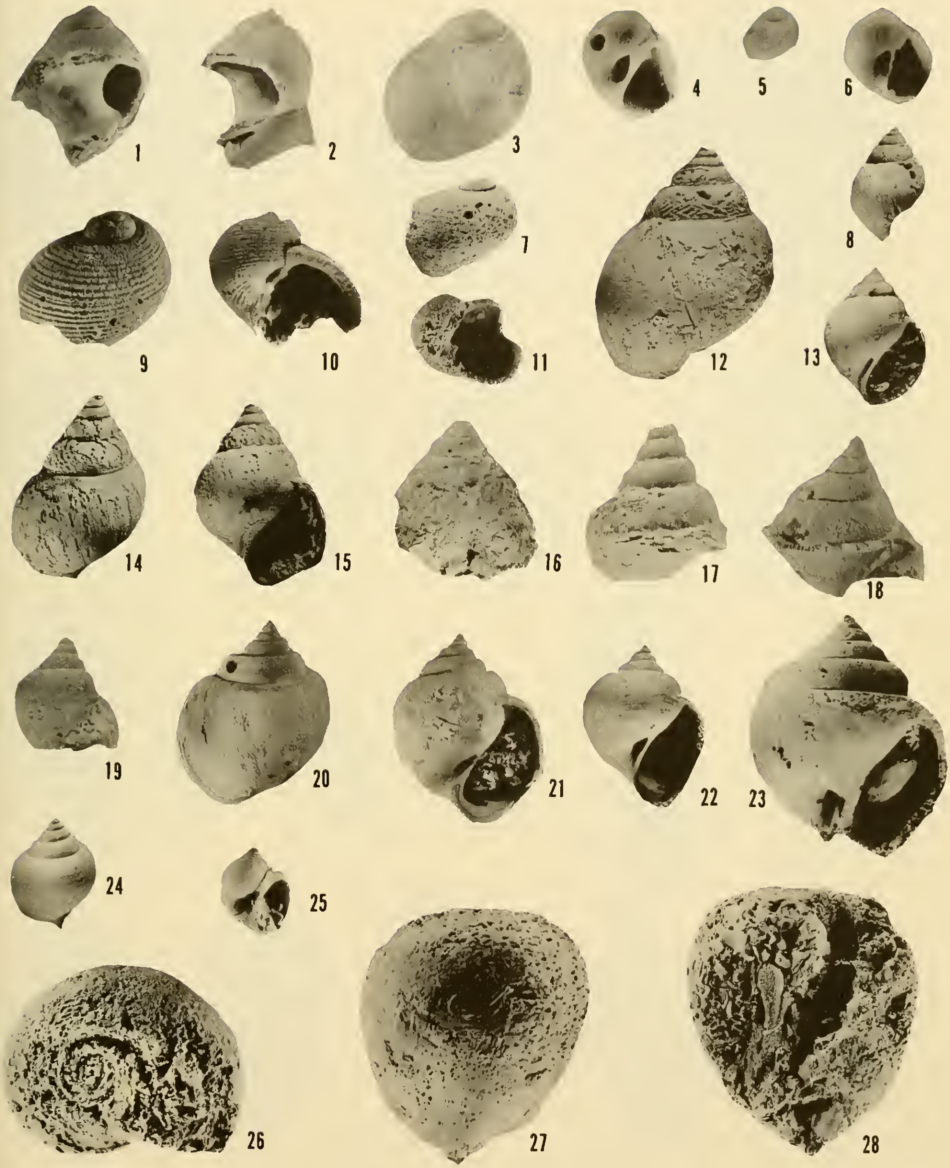
EXPLANATION OF PLATE 20

Figure		Page
1-5.	**Calyptraea nigeriensis** Adegoke, new species	127
	1-3. Apical, apertural, and umbilical views of holotype, UIMG No. 287, ×1; 4. Umbilical view of paratype, UIMG No. 288, ×4; 5. Apical view of paratype, USNM No. 174812, ×6½.	
6-8.	**Calyptraea ewekoroensis** Adegoke, new species	128
	6, 7. Apical and lateral views of holotype, UIMG No. 289, ×1⅓; 8. Apical view of paratype, USNM No. 174813, ×6½.	
9-13.	**Rimella subhumerosa** (Oppenheim)	129
	9, 10. Paratype, UIMG No. 290; 11. Paratype, UIMG No. 291; 13. Paratype, USNM No. 174814; 14. Paratype, USNM No. 174815, all ×1.	
14-20.	**Rimella ewekoroensis** Adegoke, new species	130
	14, 15. Abapertural and apertural views of holotype, UIMG No. 292, ×1⅔; 16-20. Paratype, UIMG Nos. 293, 294, USNM Nos. 174816-174818, all ×1⅔, except figure 20, ×2; note adapical nodes on body whorl and tongue-shaped parietal callus.	
21-23.	**Rimella adekunbiana** Adegoke, new species	131
	21, 22. Apertural and abapertural views of holotype, UIMG No. 295, ×1⅓; 23. Paratype, USNM No. 174819, ×1⅓.	
24-30.	**Tibia (?Amplogladius) oppenheimi** Adegoke, new species	132
	24. Holotype, UIMG No. 296, ×3⅓; 25-30. Paratypes, UIMG Nos. 297-299, USNM Nos. 174820-174822, ×3⅓.	

EXPLANATION OF PLATE 21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EXPLANATION OF PLATE 22

EXPLANATION OF PLATE 23

Figure	Page

1-6. **Sycostoma (Sycostoma) jonesi** Adegoke, new species .. 146

1, 2. Apertural and abapertural views, holotype, UIMG No. 317, ×1; 3-6. Paratypes, UIMG No. 318, USNM Nos. 174835, 174836; UIMG No. 319 same magnification as the holotype; note gently sinuous growth line trace.

7-10. **Sycostoma (Sycostoma) robusta** Adegoke, new species.. 147

7. Paratype, USNM No. 174837, ×4; 8, 9. Apertural and abapertural views of holotype, UIMG No. 320, ×1; note well-developed parietal callus; 10. Apertural view of paratype, UIMG No. 321, ×4.

11-15. **Parkeristoma guineensis** Adegoke, new genus, new species 149

11, 12. Labral and apertural views, holotype, UIMG No. 322, ×⅔; note deep growth line sinus, apical sculpture, and the median keel on body whorl; 13, 14. Abapertural and labral views of paratype, USNM No. 174838, ×⅔; 15. Apertural view, paratype, UIMG No. 323, ×⅔, note thickened outer lip and thin parietal callus.

16-20. **Parkeristoma reymenti** Adegoke, new genus, new species 150

16-18. Abapertural and apertural views, holotype, UIMG No. 324, ×1, note apical sculpture, anterior spiral sculpture, and columellar callus; 19. Apical view of tilted paratype, USNM No. 174839, ×1; 20. Labral view, paratype, UIMG No. 325, showing the sinuous growth lines, ×1.


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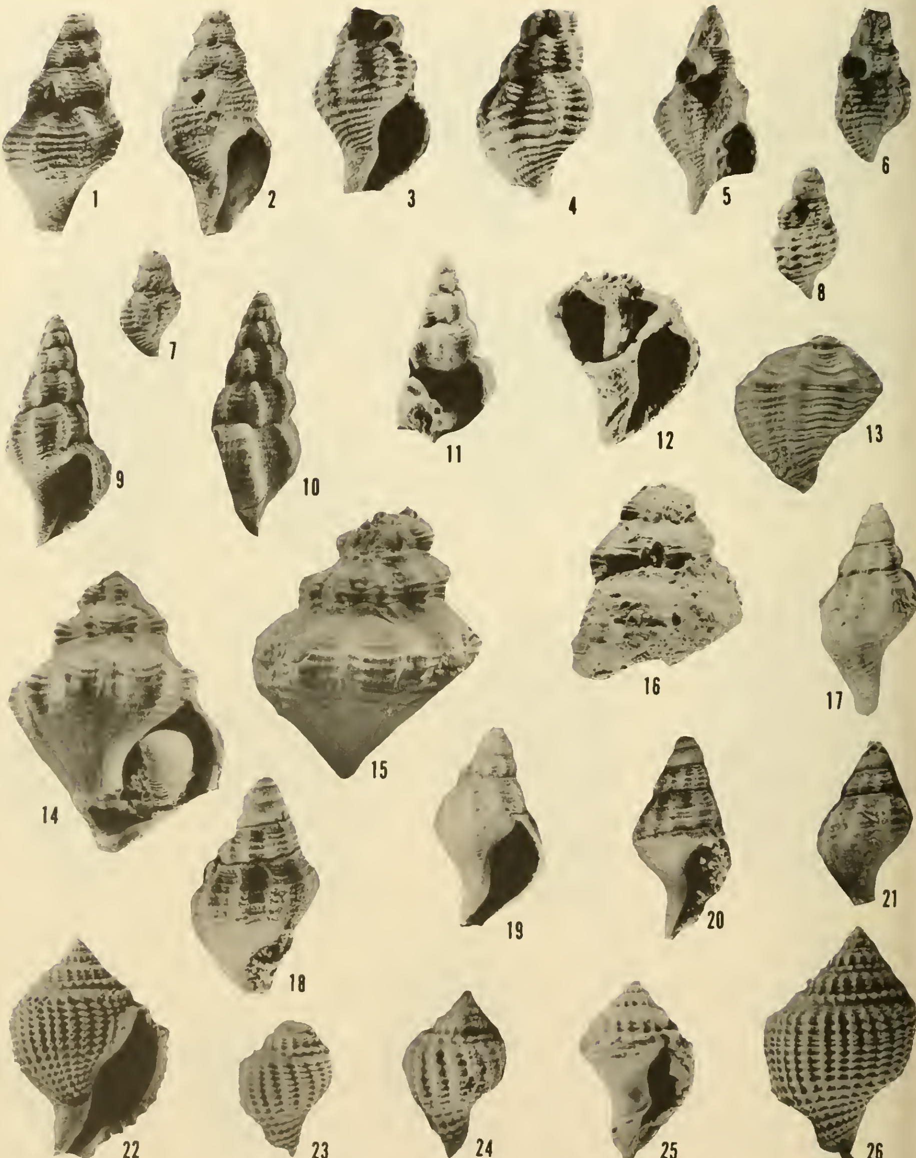
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EXPLANATION OF PLATE 24

EXPLANATION OF PLATE 25

Figure		Page
1-6.	**Strepsidura (Eamesidura) newtoni** Adegoke, new subgenus, new species	160
	1-3. Apertural, posterior, and labral views, holotype, UIMG No. 337, ×1; 4. Paratype, UIMG No. 338, ×1; 5. Apertural view of paratype, USNM No. 174849, ×1; 6. Paratype, USNM No. 174850, specimen slightly tilted to display the apical sculpture, ×1, note anterior spiral sculpture and suppression of axial ornamentation.	
7-16.	**Pseudoliva funkeana funkeana** Adegoke, new species	162
	7, 8. Aperture and abapertural views of holotype, UIMG No. 339, ×5; 9, 10. Paratype, UIMG No. 340, ×5; 11, 12. Paratype, UIMG No. 341, ×5; 13-16. Paratypes, UIMG Nos. 342, 343, USNM Nos. 174851, 174852, same magnification as holotype; note intensive predation by naticids.	
17, 18.	**Pseudoliva funkeana ornata** Adegoke, new subspecies	164
	Abapertural and apertural views, holotype, UIMG No. 344, approximately ×5, note more sinuous growth lines and anterior spiral sculpture.	
19-23.	**Pseudoliva adelekei** Adegoke, new species	165
	19-21. Various views of holotype, UIMG No. 345, ×1⅓; 22, 23. Paratype, USNM No. 174853, ×1⅓.	
24, 25.	**Pseudoliva rogersi** Adegoke, new species	166
	Holotype, UIMG No. 346, ×1, note thick shell, small aperture, and prominent axial sculpture.	
26-29.	**Pseudoliva (Buccinorbis) guineensis** Adegoke, new species	166
	26. Paratype, UIMG No. 347, ×1; 27, 29. Paratype, USNM No. 174854, ×1; 28. Paratype, UIMG No. 348, specimen tilted to display the intricate apical ornamentation, ×1.	


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EXPLANATION OF PLATE 26

Figure		Page
1-3.	**Pseudoliva (Buccinorbis) guineensis** Adegoke, new species	166
	1, 2. Abapertural and apertural views, holotype, UIMG No. 349, ×1; 3. Paratype, USNM No. 174855, ×1, note heavy parietal callosity of adults of this species.	
4-7.	**Tetrastomella? ewekoroensis** Adegoke, new species	168
	4, 5. Holotype, UIMG No. 350, ×5; 6, 7. Paratype, USNM No. 174856, ×5.	
8-12.	**Heligmotoma (Heligmotoma) nigeriensis** Adegoke, new species	170
	8-10. Abapertural, apical, and apertural views, holotype, UIMG No. 351, ×⅔; note relatively prominent apical groove and sharp flexure of the growth lines in it; 11. Paratype, UIMG No. 352, ×⅔; 12. Paratype, USNM No. 174857, ×⅔.	

EXPLANATION OF PLATE 27


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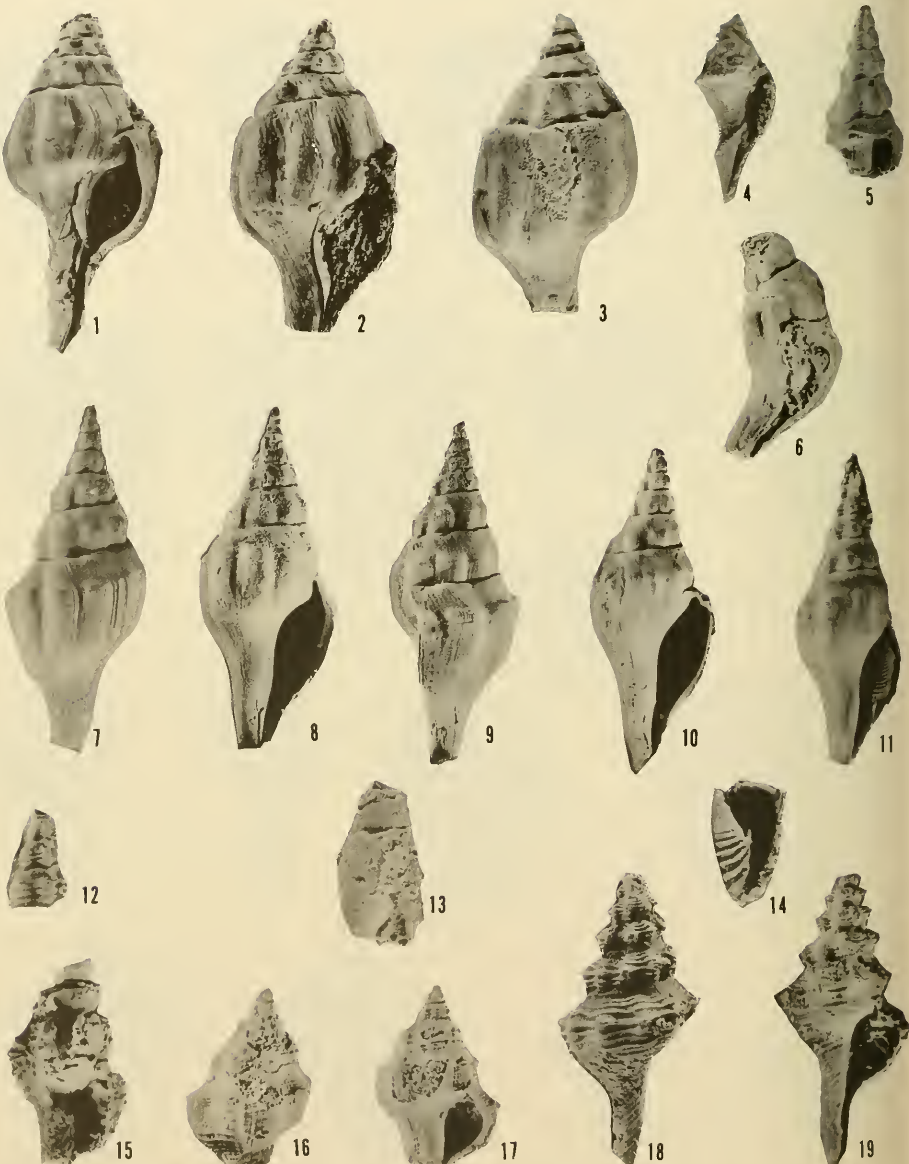
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EXPLANATION OF PLATE 28

EXPLANATION OF PLATE 29

Figure | Page

1-4. Vincenturris woodringi Adegoke, new genus, new species 185

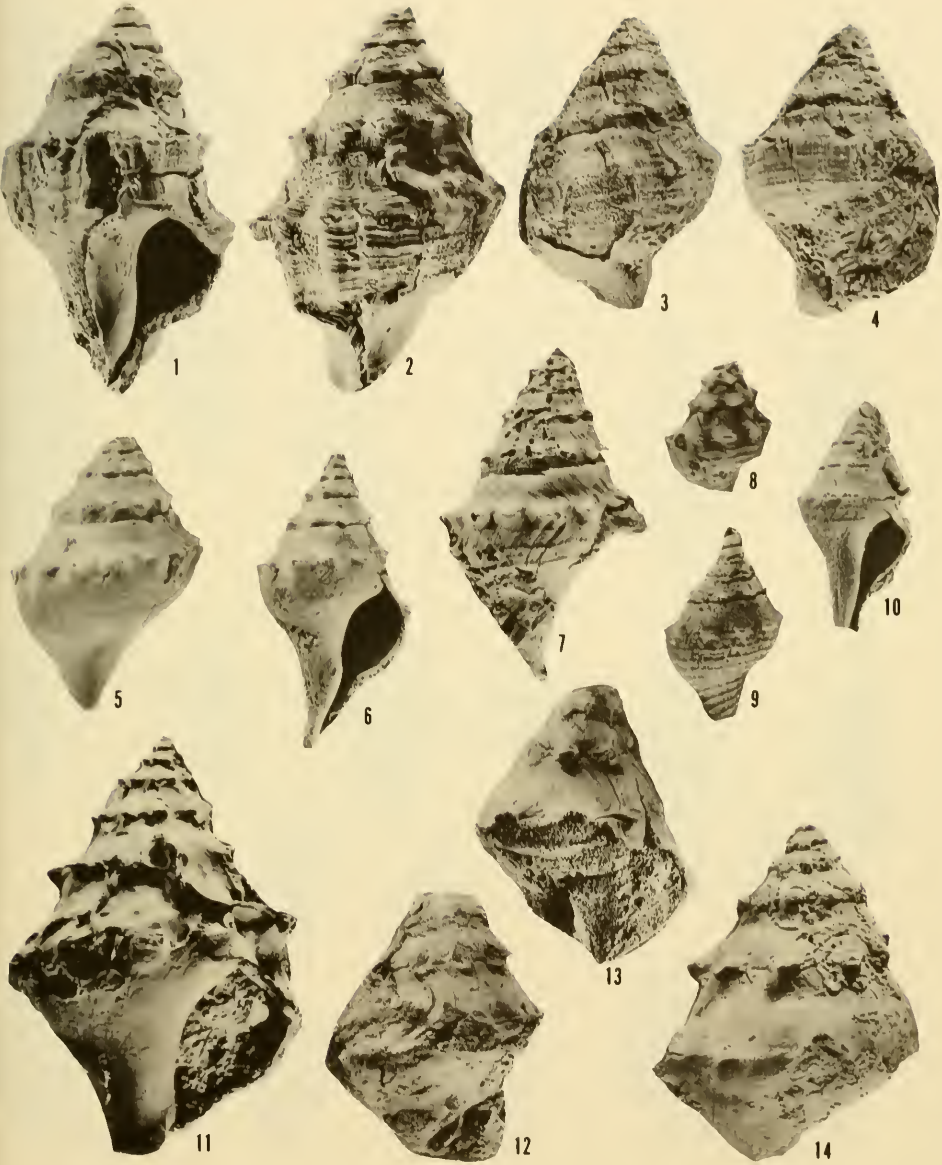
1, 2. Apertural and abapertural views, holotype, UIMG No. 368, $\times\frac{4}{3}$, note reticulate sculpture, more or less straight growth lines, and heavy columellar callosity; 3, 4. Paratype, USNM No. 174867, same magnification.

5-10. Clinuropsis togoensis (Oppenheim) 186

Hypotypes, USNM No. 174868, UIMG Nos. 144, 369-371; USNM No. 174869. Note fine spiral sculpture especially on immature specimens (figs. 8, 9) and deeply sinused growth line, $\times 1$. USNM No. 174868, $\times 1$.

11-14. Clinuropsis diderrichi nigeriensis Adegoke, new subspecies 187

11. Holotype, UIMG No. 154, approximately $\times 1$; 12, 13. Paratype, UIMG No. 153, $\times\frac{2}{3}$; 14. Paratype, USNM No. 174870, $\times 1$, note deeply sinused growth lines.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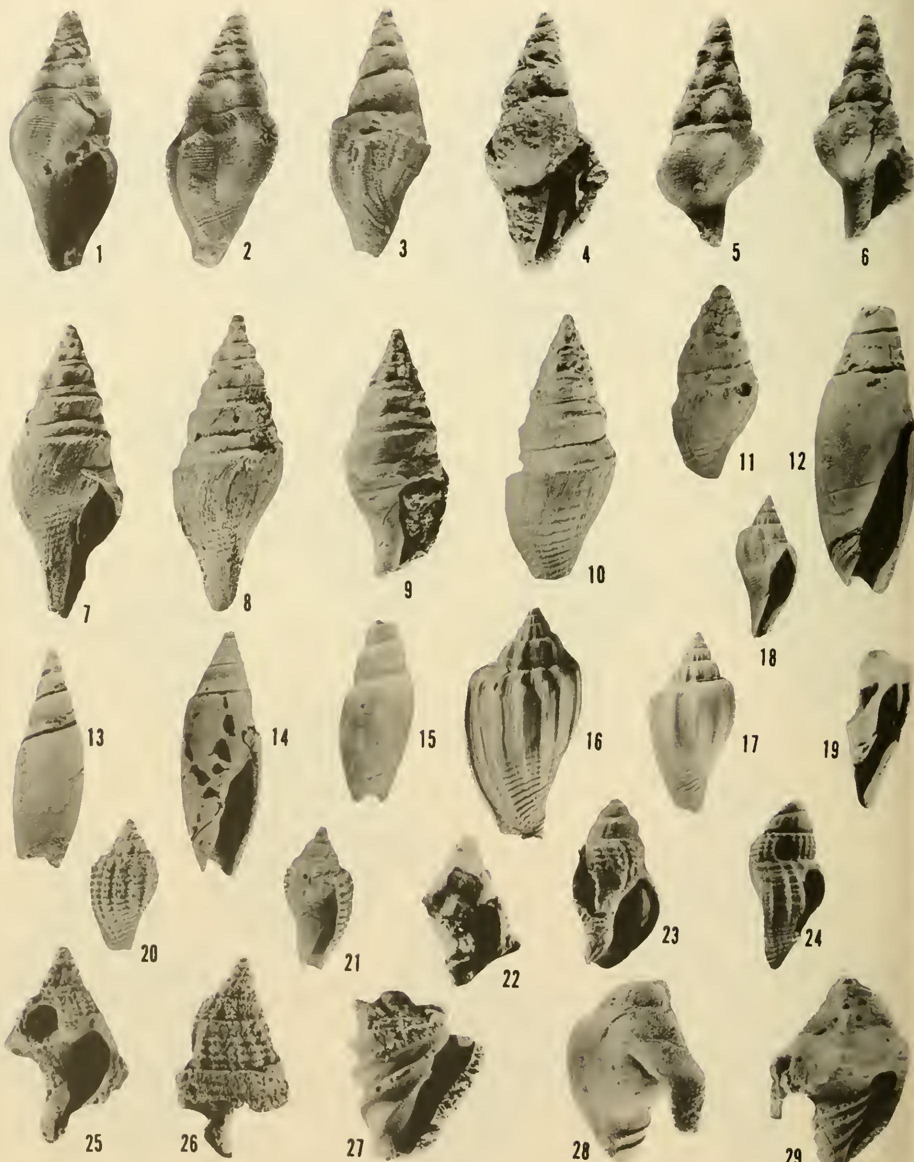
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Explanation of Plate 30

EXPLANATION OF PLATE 31

Figure | Page

1-4. **Pseudaulicina simplex** (Furon) 201
Hypotypes, UIMG Nos. 385, 386; USNM Nos. 174880, 174881, 1. ×⅔; all others ×1.

5, 6. **Conomitra guineensis** Adegoke, new species 202
Holotype, UIMG No. 156, ×1⅓.

7-10. **Vanpalmeria africana** Adegoke, new genus, new species 205
7, 8. Apertural and abapertural views, holotype, UIMG No. 388, ×3⅓; 9, 10. Paratype, USNM No. 174882, ×4, note glossy outer surface, calcitic deposit covering all the whorls, and four oblique columellar plications.

11-14. **Bayania cheneyi** Adegoke, new species 74
11. Holotype, UIMG No. 201, ×6½; 12, 13. Paratypes, UIMG No. 202; USNM Nos. 174750, 174751, same magnification.

15. ?**Bayania** sp. indet. 75
Illustrated specimen, UIMG No. 203, ×6½, note heavy callosity.

16-19. **Bonellitia (Admetula) imevborei** Adegoke, new species 206
16, 17. Apertural and abapertural views, holotype, UIMG No. 389 showing labral denticulations and varices, ×5; 18, 19. Paratype, USNM No. 174883, ×5.

20. **Bonellitia (Africostoma)** sp. indet. 207
Illustrated specimen, UIMG No. 390, ×5.

21, 22. ?**Oniscidia** sp. aff. **O. chavani** Furon 208
Hypotypes, UIMG No. 393, USNM No. 174886, ×5.

23-26. **Keilostoma septemzonatum** Cox 208
Hypotypes, UIMG Nos. 391, 392; USNM Nos. 174884, 174885, ×3⅓.

27, 28. **Bursa saundersi** Adegoke, new species 209
Holotype, UIMG No. 394, apertural and abapertural views showing varices, ×1.


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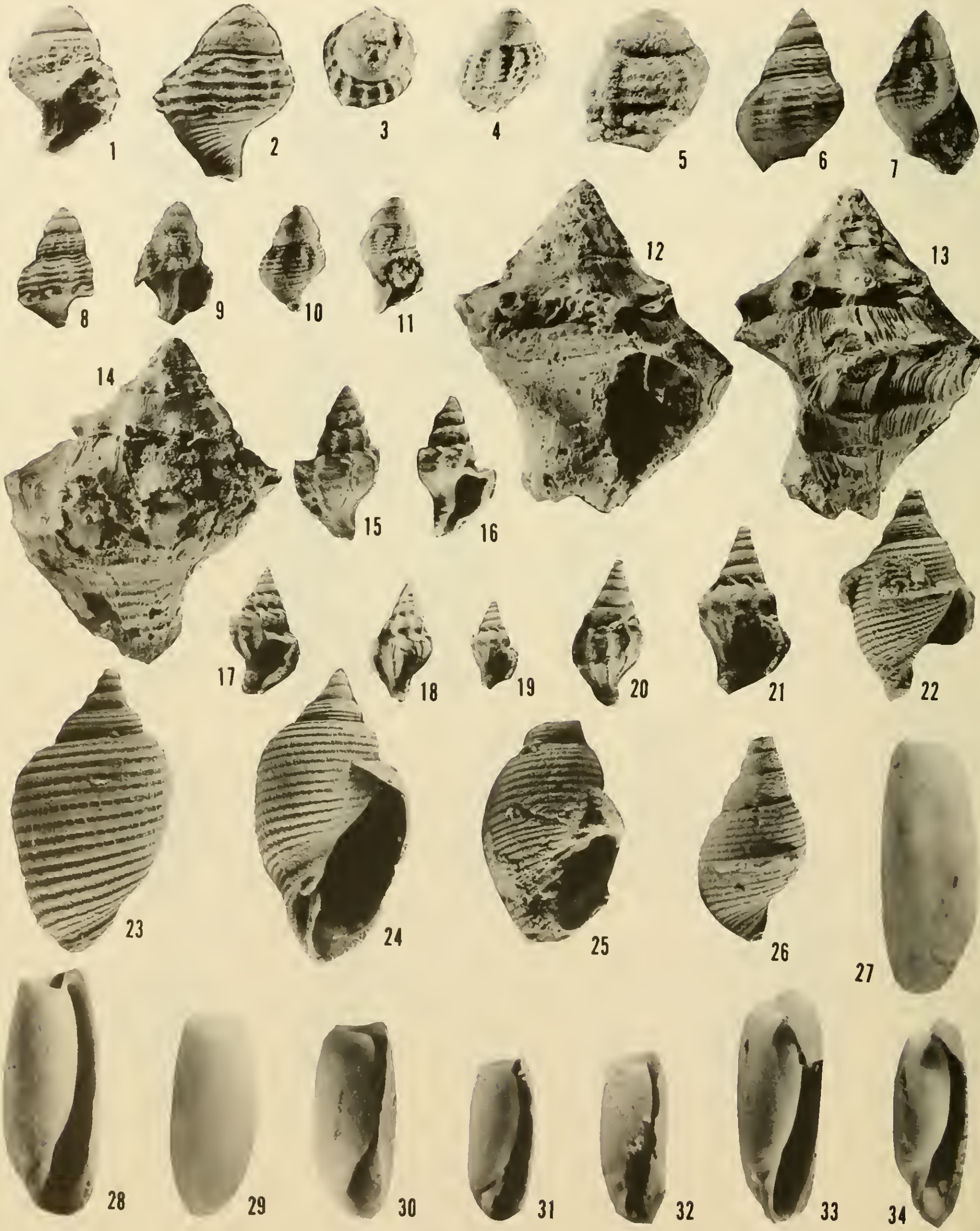
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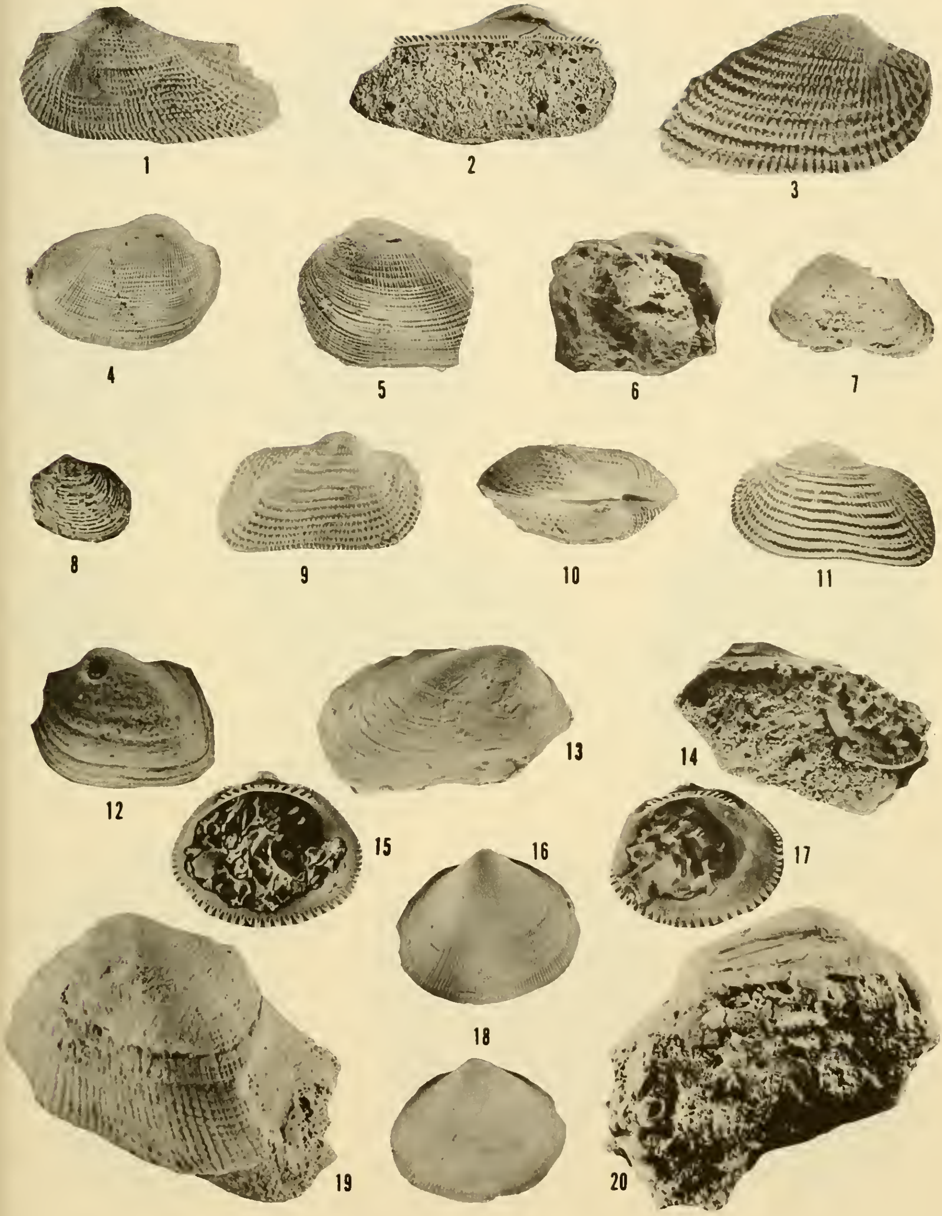
Explanation of Plate 32

EXPLANATION OF PLATE 33

Figure		Page
1-3.	**Arca (Arca) accra** Cox Hypotypes, 1, 2. UIMG No. 414, ×1⅓; 3. USNM No. 174895, ×6½.	218
4-6.	**Barbatia (Barbatia) nigeriensis** Adegoke, new species 4. Holotype, UIMG No. 415, ×1; 5, 6. Paratype, USNM No. 174896, ×1⅓.	219
7.	**Barbatia (Barbatia) ewekoroensis** Adegoke, new species Holotype, UIMG No. 416, ×2.	220
8.	**Barbatia (Barbatia) yoloyei** Adegoke, new species Holotype, UIMG No. 417, ×10.	220
9-11.	**Barbatia (Acar) micronodosa** Adegoke, new species Holotype. UIMG No. 418, ×2.	221
12.	**Barbatia (Acar)** sp. aff. **B. (A.) putealis** Cox Hypotype, UIMG No. 419, ×5.	222
13, 14.	**Cucullaria coxi** Adegoke, new species Holotype, UIMG No. 420, ×2.	222
15-18.	**Glycymeris (Glycymeris) togoensis** Oppenheim Hypotypes, 15, 16. UIMG No. 422, ×2; 17, 18. USNM No. 174897, same magnification.	224
19, 20.	**Cucullaea ewekoroensis** Adegoke, new species Holotype, UIMG No. 421, ×1.	223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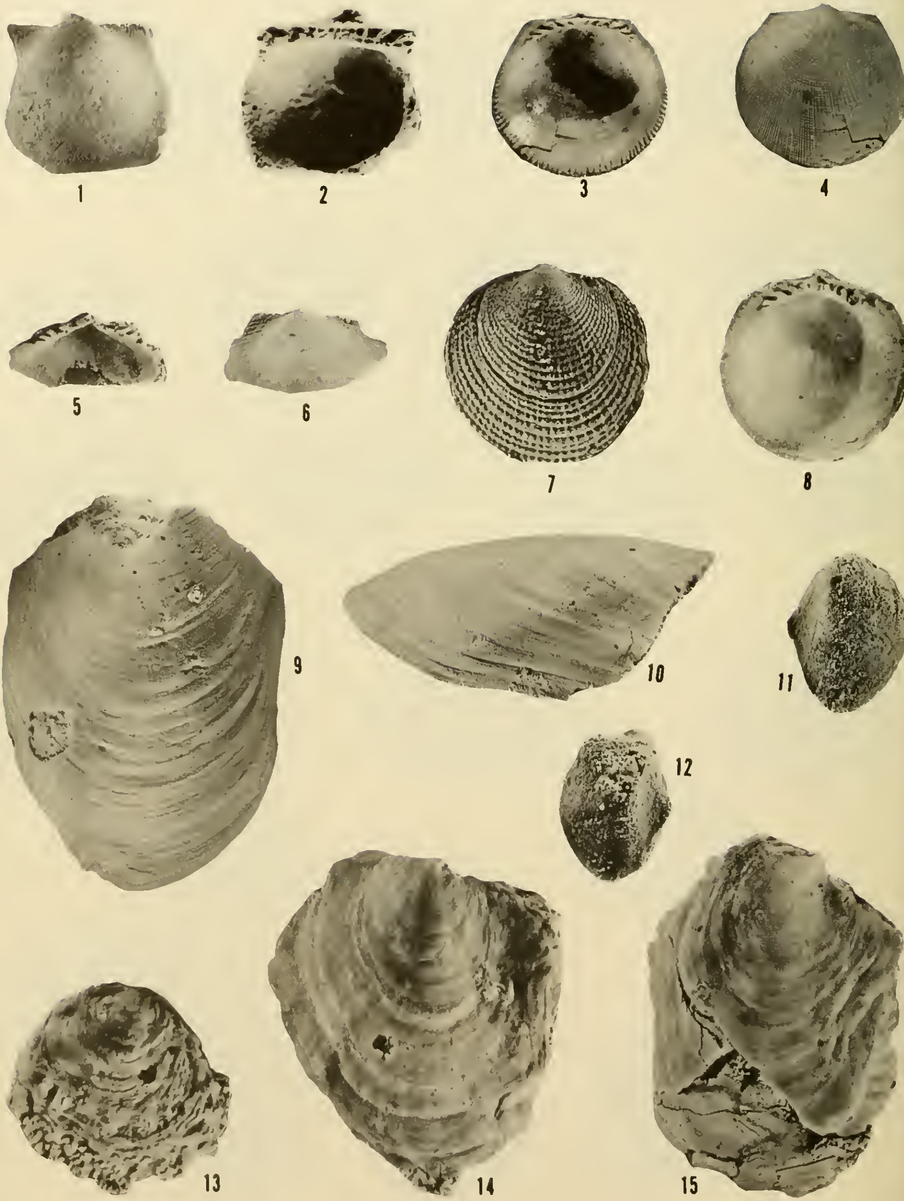
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EXPLANATION OF PLATE 34

Figure		Page
1, 2.	**Glycymeris (Glycymeris) subtogoensis**? (Furon) .... Hypotype, UIMG No. 423, ×5.	225
3, 4.	**Glycymeries (?Glycymeris) guineensis** Adegoke, new species .... Holotype, UIMG No. 424, ×2, note fine exterior sculpture, thin shell, and the reflections of sculpture on interior surface of the shell.	226
5, 6.	**Glycymeris** sp. **A** .... UIMG No. 425, ×3⅓.	227
7, 8.	**Glycymeries (Ewekoromeris) ewekoroensis** Adegoke, subgenus, new species .... Holotype, UIMG No. 426, ×6½, note coarse exterior sculpture and smooth interior margin.	228
9, 10.	**Mytilus nigeriensis** Adegoke, new species .... Holotype, UIMG No. 427, ×1.	229
11, 12.	**Modiolus** sp. indet. .... UIMG No. 428, ×5.	229
13-15.	**Vulsella walleri** Adegoke, new species .... 13. Paratype, UIMG No. 429, ×1⅓; 14. Holotype, UIMG No. 430, ×1⅓; 15. Paratype, USNM No. 174898, ×1⅓.	231

EXPLANATION OF PLATE 35

Figure		Page
1, 2.	**Plicatula (Darteplicatula) gorodiskii** Adegoke, new species .... Holotype, UIMG No. 431, $\times 5$.	232
3-9.	**Plicatula costaeirregularis** Adegoke, new species .... 3. Holotype, UIMG No. 432, $\times 3\frac{1}{3}$; 4-9. Paratypes, UIMG Nos. 433, 434, 435 (figures 6, 7), USNM Nos. 174899, 174900, $\times 3\frac{1}{3}$.	233
10-24.	**Anomia cooperi** Adegoke, new species .... 10, 11. Holotype, UIMG No. 436, $\times 3\frac{1}{3}$; 12-24. Paratypes, UIMG Nos. 437-443, USNM Nos. 174901-174906. 12-16. $\times 3\frac{1}{3}$, all others $\times 2$.	234
25.	**Ostrea** sp. indet. .... Hypotype, UIMG No. 444, $\times 1\frac{1}{3}$.	242


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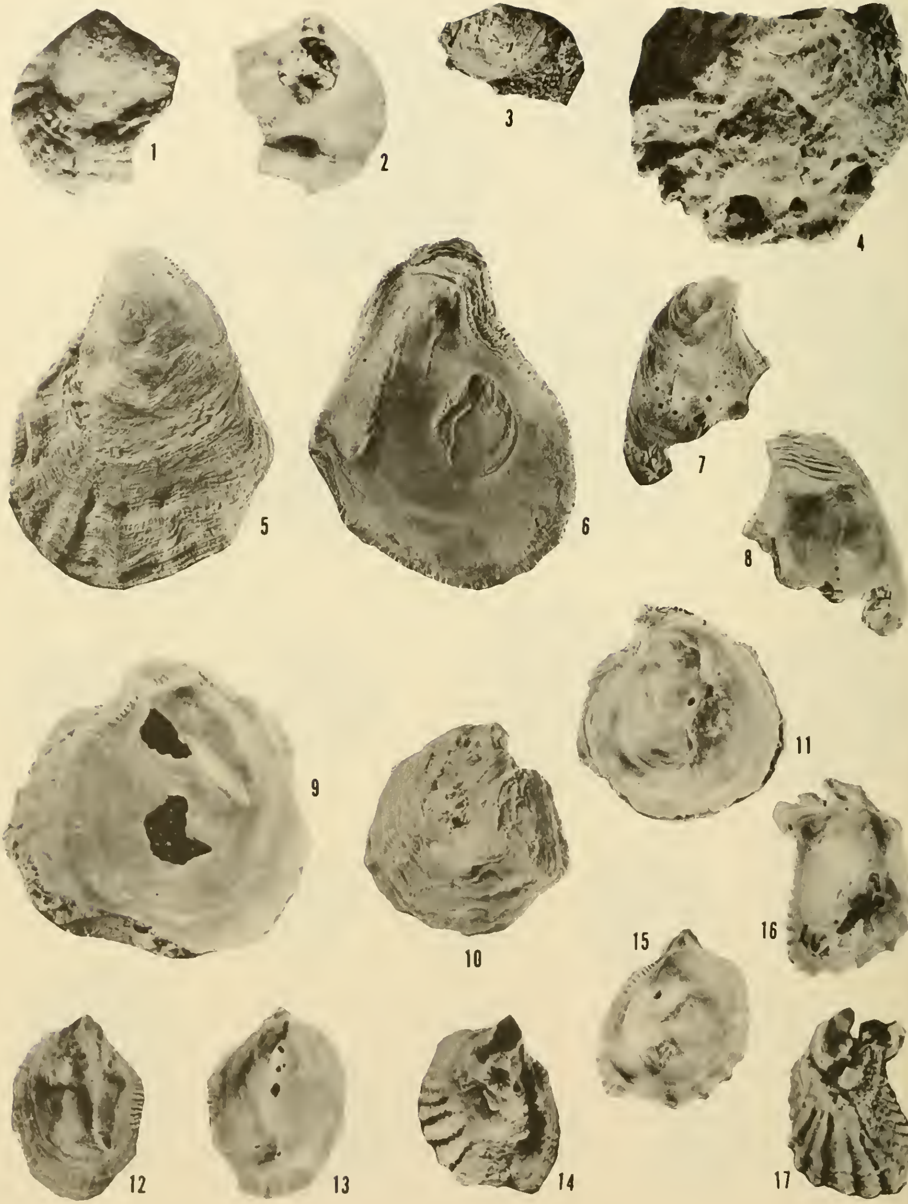
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Explanation of Plate 36

Figure		Page
1-4.	**Carolia? freneixi** Adegoke, new species	235
	1, 2. Holotype, UIMG No. 445, ×3⅓; 3. Paratype, UIMG No. 446, ×3⅓; 4. Paratype, USNM No. 174907, ×3⅓.	
5-8.	**Ostrea meunieri nigeriensis** Adegoke, new subspecies..	238
	5, 6. Exterior and interior views of valve, holotype, UIMG No. 447, ×1; 7, 8. Paratype, USNM No. 174908, ×1, note fine reticulate exterior sculpture, coarse radial plications, and hemispherical muscle scar impression.	
9-17.	**Ostrea sohli** Adegoke, new species	239
	9. Paratype, UIMG No. 448, ×1; 10, 11. Exterior and interior views of holotype, UIMG No. 449, ×1; 12, 13. Paratype, UIMG No. 450, ×1, 14, 15. Paratype, USNM No. 174909, ×1; 16, 17. Paratype, USNM No. 174910, ×1⅓, note strongly folded exterior margin and relatively small attachment area.	

EXPLANATION OF PLATE 37

Figure		Page
1-9.	**Ostrea kauffmani** Adegoke, new species	240
	1. Paratype, UIMG No. 451, ×1⅓; 2. Paratype, UIMG No. 452, ×1⅓; 3, 4. Exterior and interior views, holotype, UIMG No. 453, ×1⅓; 5-9. Paratype, UIMG Nos. 452, 454, USNM Nos. 174911-174913, ×1⅓, note crenulated margins, the semilunar muscle scar, and strongly curved beaks.	
10-12.	**Ostrea durotoyei** Adegoke, new species	242
	10. Holotype, UIMG No. 455, ×1⅓; 11. Paratype, UIMG No. 456, ×1⅓; 12. Paratype, USNM No. 174914, ×1⅓.	
13-17.	**Ostrea abeokutaensis** Adegoke, new species	243
	13. Paratype, UIMG No. 457, ×3⅓; 14, 17. Holotype, UIMG No. 458, ×6½; 15. Paratype, UIMG No. 459, ×3⅓; 16. Paratype, USNM No. 174915, ×3⅓.	


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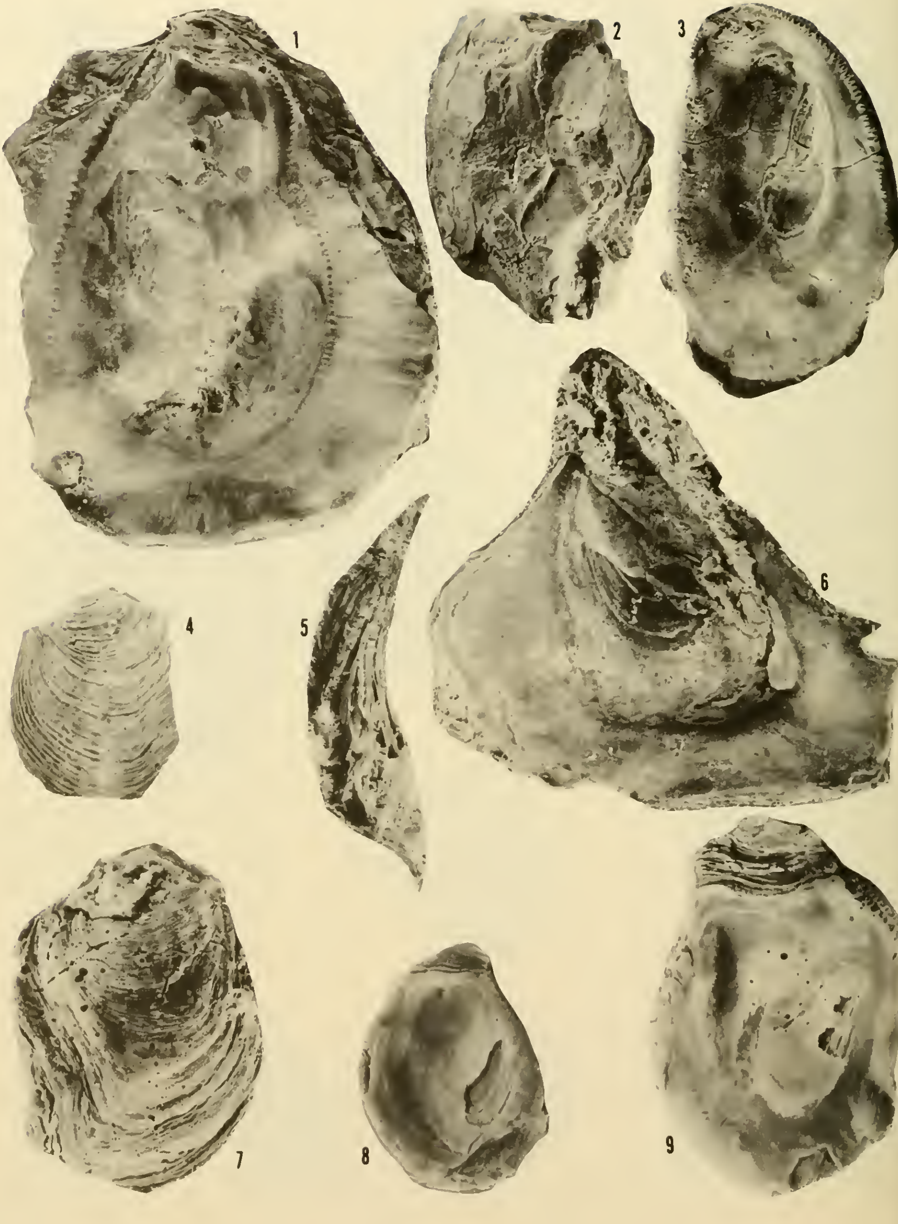
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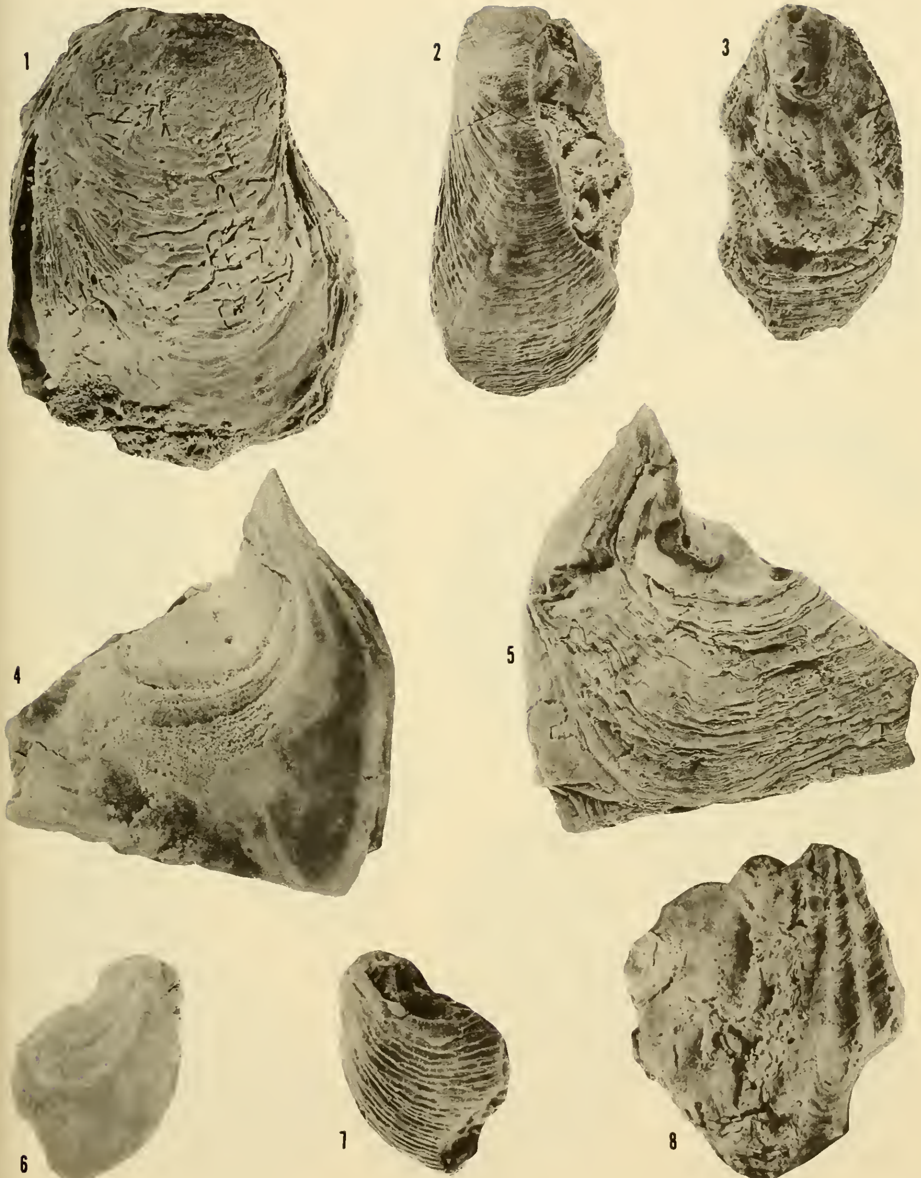
EXPLANATION OF PLATE 38

Figure		Page
1, 5, 6.	**Ostrea olowui** Adegoke, new species	244
	1. Holotype, UIMG No. 460, ×⅔; 5, 6. Interior and side views, paratype, UIMG No. 461, ×⅔, note complete pallial denticulation and broad, flattened margin.	
2.	?**Crassostrea** sp. indet.	248
	UIMG No. 473, ×⅔.	
3, 4, 7-9.	**Ostrea paleomarginidentata** Adegoke, new species	245
	Paratypes, 3. UIMG No. 462, ×1; 4. UIMG No. 463, ×1; 7, 9. UIMG No. 464, ×1; 8. USNM No. 174917, ×1, note broad hinge area and obliquely elongate adductor muscle impression.	

EXPLANATION OF PLATE 39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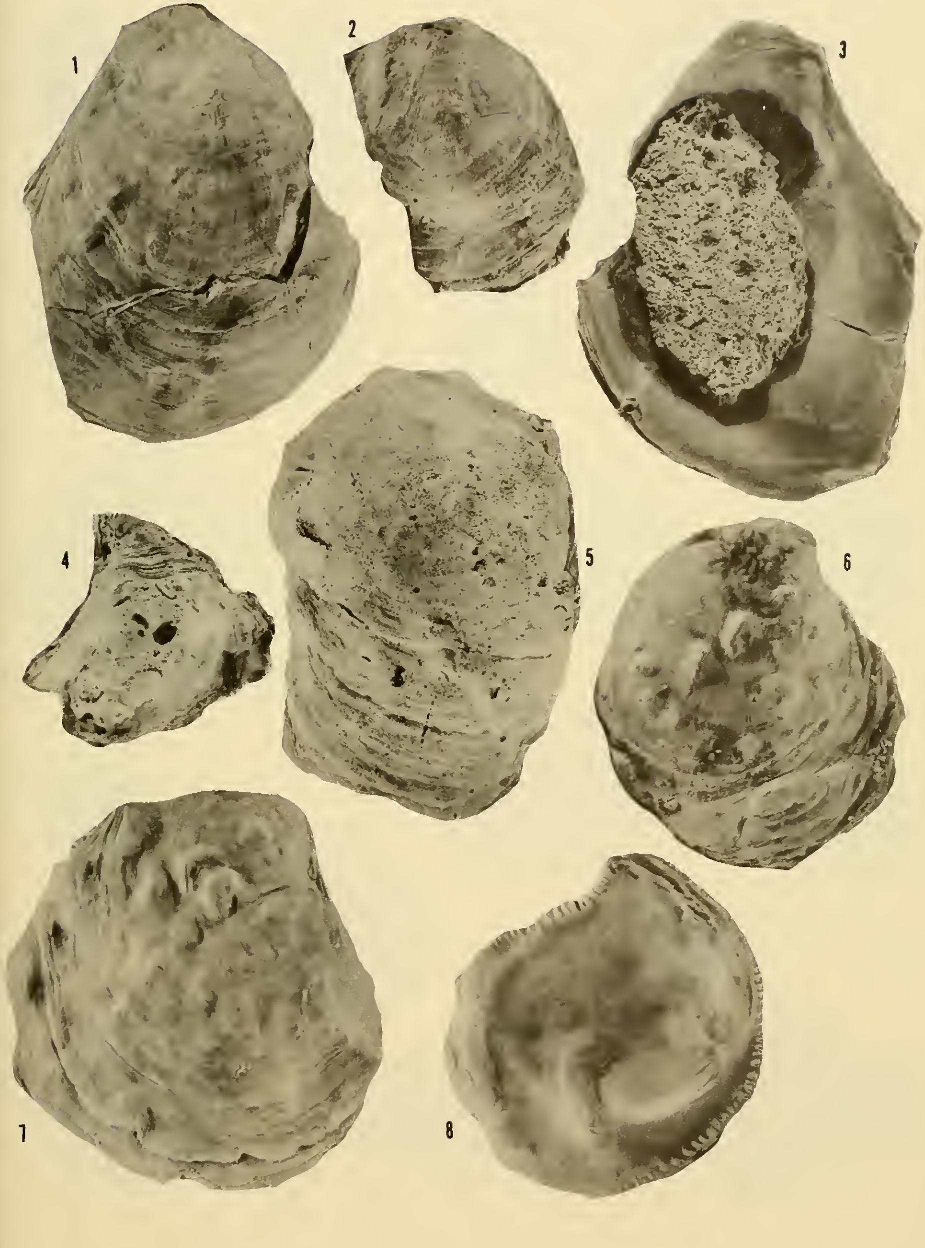
EXPLANATION OF PLATE 40

Figure		Page
1-4.	**Ostrea asseezi** Adegoke, new species	246
	1, 4. Paratype, USNM No. 174921, ×⅔; 2. Interior of valve, holotype, UIMG No. 468, ×⅔; 3. Paratype, UIMG No. 469, ×1.	
5-11.	**Ostrea omatsolae** Adegoke, new species	247
	5, 6. Interior and exterior views, paratype, UIMG No. 470, ×1⅓; 7. Paratype, UIMG No. 471, ×1⅓; 8, 9. Exterior and interior views, holotype, UIMG No. 472, ×1⅓; 10. Paratype, USNM No. 174923, ×2⅔; 11. Paratype, USNM No. 174924, note wrinkled exterior, small hinge area, and variable outline.	
12-15.	**Pycnodonte ewekoroensis** Adegoke, new species	249
	12, 13. Paratype, USNM No. 174925, ×⅔; 14, 15. Paratype, UIMG No. 474, ×⅔.	

EXPLANATION OF PLATE 41

Figure		Page
1-3, 5.	**Pycnodonte ewekoroensis** Adegoke, new species	249
	1, 3. Exterior and interior views, holotype, UIMG No. 475, approximately ×⅔; 2. Paratype, USNM No. 174926, ×⅔; 5. Paratype, UIMG No. 476, ×⅔.	
4.	**Ostrea asseezi** Adegoke, new species	246
	Interior view, paratype, USNM No. 174922, ×⅔.	
6-8.	**Pycnodonte nigeriensis** Adegoke, new species	250
	6, 8. Exterior and interior views, holotype, UIMG No. 477, ×1; 7. Paratype, UIMG No. 478, ×1, note coarse marginal denticulations and small hinge area.	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EXPLANATION OF PLATE 42

Figure		Page
1.	**Pycnodonte nigeriensis** Adegoke, new species .... Paratype, USNM No. 174927, ×⅔.	250
2, 3.	**Ostrea** spp. .... 2. UIMG No. 479, ×3⅓; 3. UIMG No. 479, ×2.	248
4-7.	**Parvilucina chavani** Adegoke, new species .... 4, 5. Interior and exterior views, holotype, UIMG No. 481, ×3⅓; 6, 7. Same views, paratype, USNM No. 174928, ×3⅓.	251
8-10.	**Parvilucina elegantissima** Adegoke, new species .... 8, 9. Exterior and interior views, holotype, UIMG No. 482, ×10; 10. Paratype, USNM No. 174929, ×10.	252
11-13.	**Miltha africana** Adegoke, new species .... 11. Paratype, USNM No. 174930, ×1⅓; 12, 13. Exterior and interior views, holotype, UIMG No. 483, ×1⅓.	253
14-17.	**Anodontia (Afranodontia) marginidentata** Adegoke, new subgenus, new species .... 14, 15. Paratype, USNM No. 174931, ×3⅓; 16, 17. Exterior and interior views, holotype, UIMG No. 484, ×3⅓, note small edentulous hinge and denticulate margin.	255
18, 19.	?**Fimbria** sp. cf. **F. furoni** Cox .... Hypotype, UIMG No. 485, ×6½.	255

Explanation of Plate 43


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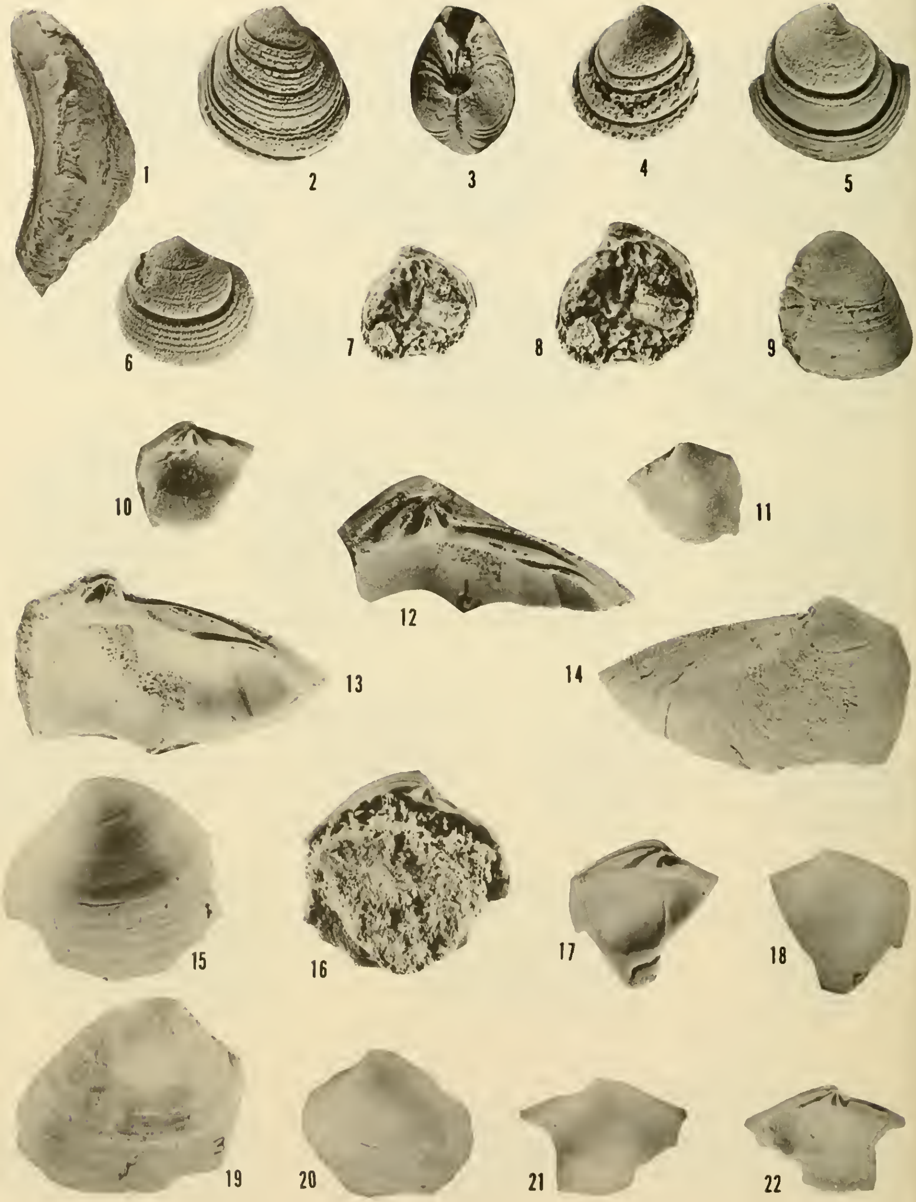
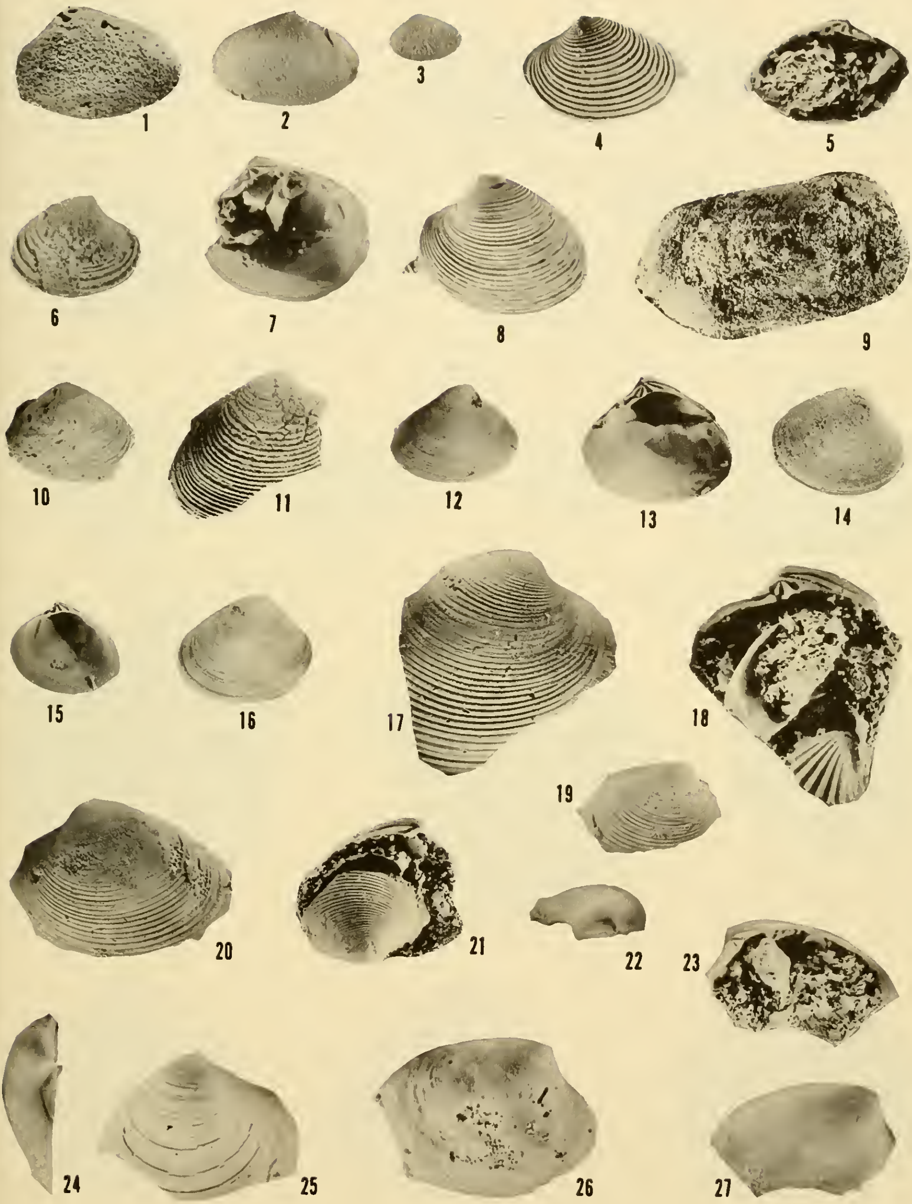


EXPLANATION OF PLATE 44

Figure		Page
1.	**Kitsonia paleocenica** Adegoke, new species Holotype, UIMG No. 493, ×2.	277
2-8.	**Glossus (Cytherocardia) nigeriana** Adegoke 2, 3. Lateral and umbonal views, holotype, UIMG No. 494, ×3⅓, note small, strongly depressed lunule; 4. Paratype, UIMG No. 495, ×3⅓; 5. Paratype, UIMG No. 496, ×3⅓; 6. Paratype, USNM No. 174933, ×3⅓; 7, 8. Paratype, USNM No. 174934, ×3⅓ and ×4 respectively.	277
9.	**Corbicula (Corbicula)** sp. indet. Illustrated specimen, UIMG No. 497, ×2.	279
10-14, 21, 22.	**"Corbicula" serrodentata** Adegoke, new species 10, 11. Paratype, UIMG No. 499, ×3⅓; 12-14. Views of interior and exterior, holotype, UIMG No. 498, ×3⅓; note figure 13 is tilted slightly to show serrations on anterior lateral tooth; 21, 22. Exterior and interior views, paratype, USNM No. 174935, ×2⅔.	280
15-20.	**Pitar (Pitar) ewekoroensis** Adegoke, new species 15, 16. Exterior and interior views, holotype, UIMG No. 500, ×1⅓; 17, 18. Paratype, USNM No. 174936, ×1⅓; 19. Paratype, UIMG No. 501, ×1⅓; 20. Paratype, UIMG No. 502, ×1⅓.	280

EXPLANATION OF PLATE 45

Figure		Page
1-3.	**Tellina (Elliptotellina) kouriatchyi** Furon	274
	Hypotypes, 1. UIMG No. 491, ×5; 2. UIMG No. 492, ×3⅓; 3. USNM No. 174932, ×3⅓.	
4-8.	**Costacallista adabionensis** (Oppenheim)	281
	Hypotypes, 4, 5. UIMG No. 503, ×1⅓; 6. UIMG No. 504, ×1⅓; 7. UIMG No. 505, ×1⅓; 8. USNM No. 174937, ×1⅓.	
9.	Unidentified pelecypod	291
	UIMG No. 577, ×⅔.	
10, 11.	?**Macrocallista aurilitoralis** Cox	282
	Hypotypes, 10. UIMG No. 506, ×2; 11. USNM No. 174938, ×2.	
12-16.	**Macrocallista gruneri** (Oppenheim)	283
	Hypotypes, UIMG Nos. 507-510, USNM No. 174939 respectively; fig. 12, ×4, all others ×2.	
17-22.	**Macrocallista ewekoroensis** Adegoke, new species	284
	17, 18. Exterior and interior views, holotype, UIMG No. 511, ×1⅓; paratypes; 19. UIMG No. 512, ×1⅓; 20. USNM No. 182375, ×1⅓; 21. UIMG No. 513, ×1⅓; 22. UIMG No. 514, ×1⅓.	
23-27.	**Macrocallista lunulata** Adegoke, new species	285
	23, 27. Paratype, USNM No. 182376, ×1⅓; 24, 25. Lunule and posterior views, holotype, UIMG No. 515, ×1⅓, note broad and distinctly delimited lunule; 26. Paratype, UIMG No. 516, ×1⅓.	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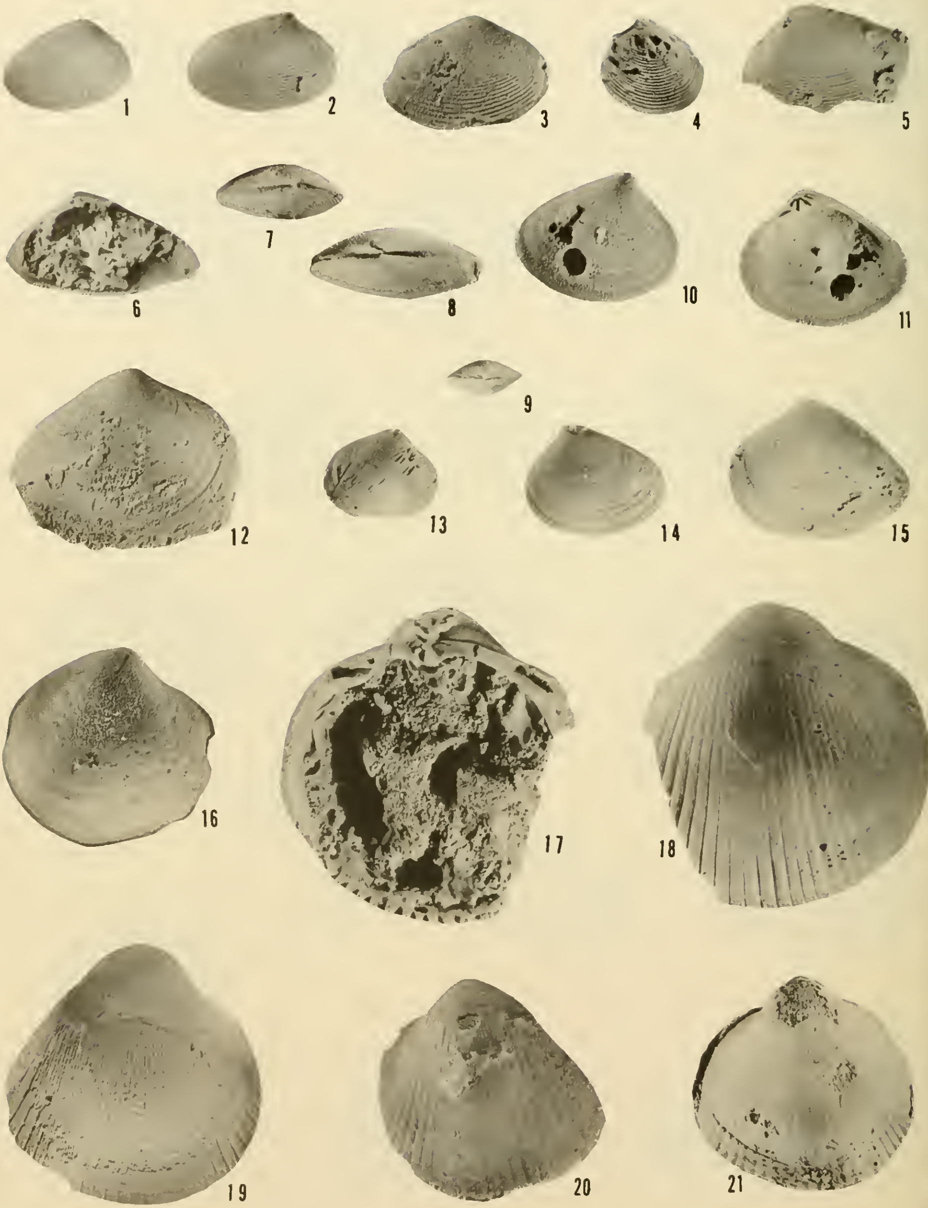
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Explanation of Plate 46

Figure		Page
1-8.	**Macrocallista femii** Adegoke, new species	286
	1, 7. Exterior and umbonal views, holotype, UIMG No. 517, ×3⅓; Paratypes, 2. UIMG No. 518, ×3⅓; 3, 8. USNM No. 182377, ×3⅓; 4. UIMG No. 519, ×6½; 5. UIMG No. 520, ×3⅓; 6. Paratype, USNM No. 182378, ×3⅓.	
9-15.	**Transennella africana** Adegoke, new species	287
	9. Paratype, UIMG No. 556, ×3⅓; 10, 11. Exterior and interior views, holotype, UIMG No. 555, ×3⅓; paratypes; 12. UIMG No. 557, ×3⅓; 13. USNM No. 185582, ×3⅓; 14. USNM No. 185583, ×3⅓; 15. USNM No. 185584, ×2⅔.	
16.	**Dosiniopsis ewekoroensis** Adegoke, new species	287
	Holotype, UIMG No. 231, ×3⅓.	
17-19.	**Cardium (Cardium) zechi** Oppenheim	268
	Hypotypes, 17, 18. UIMG No. 381, ×⅔; 19. USNM No. 185039, ×⅔.	
20, 21.	**Cardium (Cardium) guineense** Adegoke, new species	269
	Paratypes, 20. UIMG No. 524, ×⅔; 21. UIMG No. 525, ×⅔.	

EXPLANATION OF PLATE 47


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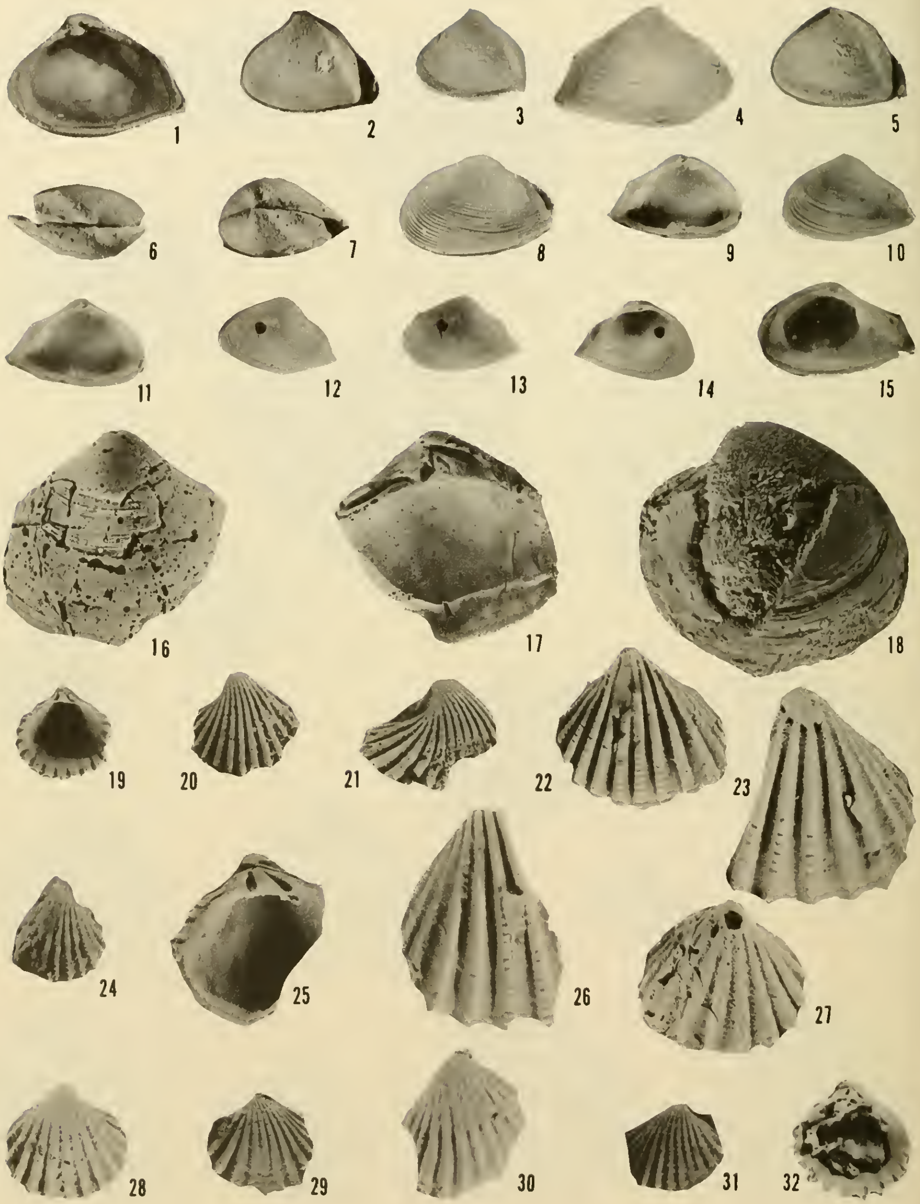
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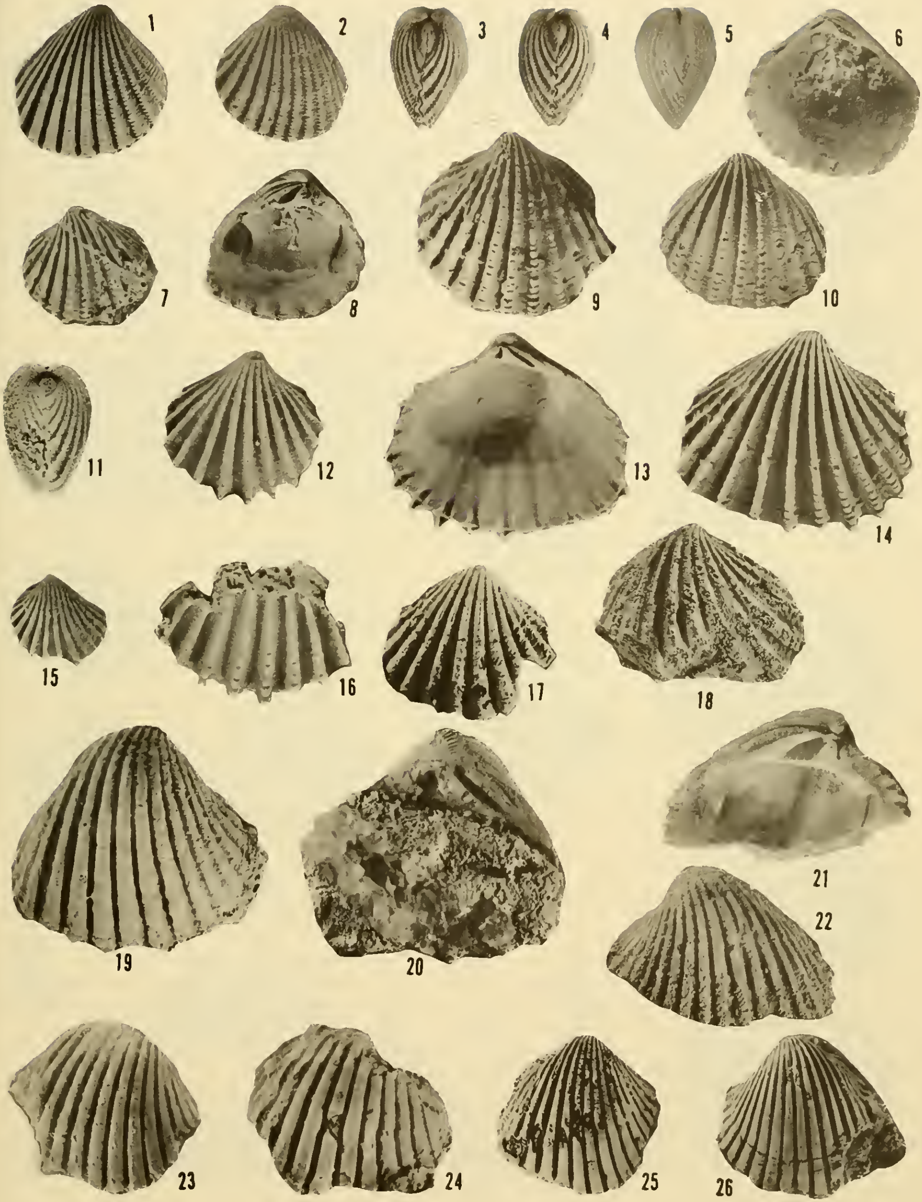
Explanation of Plate 48

EXPLANATION OF PLATE 49

Figure		Page
1-6.	**Venericardia ewekoroensis** Adegoke, new species	263
	1. Holotype, UIMG No. 539, ×3⅓; 2. Left valve, paratype, UIMG No. 540, ×3⅓; 3, 4. Anterior views, paratypes, UIMG No. 541, USNM No. 185053 respectively showing elevated lunule, ×3⅓; 5. Posterior view, paratype, USNM No. 185054 showing depressed, V-shaped escutcheon, ×3⅓; 6. Interior view a right valve, paratype, USNM No. 185055, showing hinge, ×3⅓.	
7-10.	**Venericardia costagranosa** Adegoke, new species	264
	7, 8. Exterior view, holotype, UIMG No. 542, ×1⅓; 8. Paratype, UIMG No. 543, ×1⅓; 9. Paratype, USNM No. 185056, ×2; 10. Paratype, USNM No. 185057, ×2, note distant and coarsely noded ribs.	
11-16.	**Venericardia angusticosta** Adegoke, new species	265
	11. Paratype, UIMG No. 544, anterior view showing lunule, ×3⅓; 12. Paratype, USNM No. 185058, ×3⅓; 13, 14. Interior and exterior view, holotype, UIMG No. 546, ×3⅓; 15. Paratype, UIMG No. 545, ×3⅓; 16. Paratype, USNM No. 185059, ×3⅓, note narrow, highly elevated radial costae.	
17, 18.	**Venericardia togoensis** (Oppenheim)	266
	Hypotypes, UIMG No. 547; USNM No. 185060, ×2.	
19-26.	**Venericardia (Venericor) nigeriana** Adegoke, new species	260
	19, 20. Holotype, UIMG No. 158, exterior and interior views, right valve, ×1; 21, 22. Paratypes, UIMG No. 530, ×1, interior view showing cardinal area and exterior view showing planicostate ribs; 23. Paratype, UIMG No. 531, ×1; 24, 26. Paratypes, USNM Nos. 185044-185046, ×1, note typical *Venericor* planicostate ribs of this species and the close resemblance to *V. mediaplata* Gardner and Bowles.	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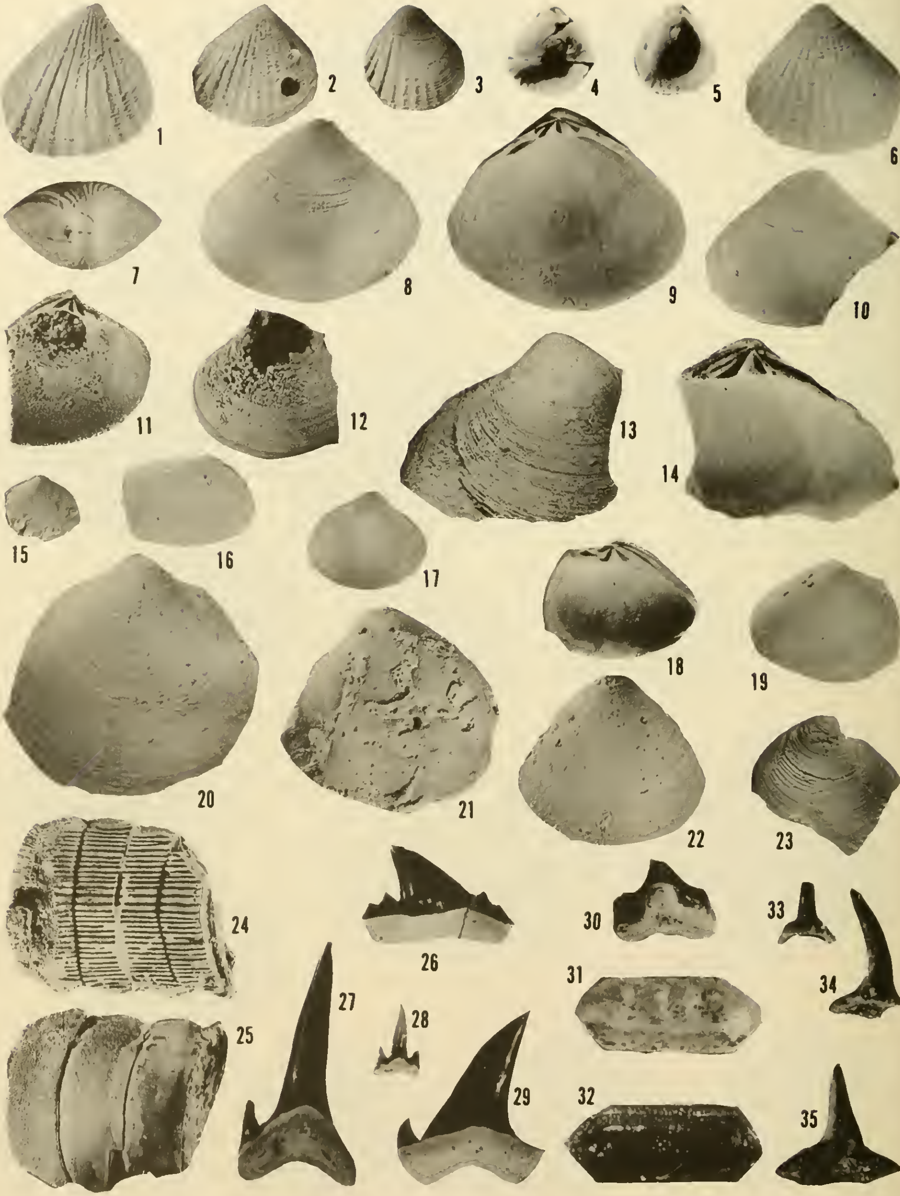
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EXPLANATION OF PLATE 50

Figure		Page
1-7.	**Carditella baloguni** Adegoke, new species	266
	1, 7. Exterior view, right valve and umbonal view, holotype, UIMG No. 548, ×3⅓; 2-6. Views of paratypes, UIMG Nos. 549, 550, USNM No. 185061-185063, ×3⅓.	
8-10.	**Spisula (Crepispisula) nigeriensis** Adegoke, new species	272
	8, 9. Exterior and interior views, holotype, UIMG No. 564, ×2; 10. Paratype, USNM No. 185589, ×2.	
11-14.	**Tivelina ewekoroensis** Adegoke, new species	289
	11, 12. Holotype, UIMG No. 565, ×3⅓; 13, 14. Paratype, USNM No. 185590, ×3⅓.	
15.	**Tellina (?Arcopagia)** sp. indet.	
	USNM No. 185591, ×1⅓.	
16.	**Notodonax? (Protodonax) nigeriana** Adegoke, new species	275
	Left valve, holotype, UIMG No. 566, ×3⅓.	
17.	**Spisula (Notospisula) ewekoroensis** Adegoke, new species	273
	View of right valve, holotype, UIMG No. 567, ×3⅓.	
18, 19.	**Aeora? africana** Adegoke, new species	288
	Interior and exterior views, holotype, UIMG No. 568, ×2.	
20-22.	**?Glycymeris** sp. B	227
	UIMG No. 569, USNM Nos. 185592, 185593, ×2.	
23.	**Parvilucina elegantissima** Adegoke, new species	252
	Paratype, UIMG No. 563, ×3⅓.	
24, 25.	**Myliobatis** sp. indet.	298
	Lower and upper views of tooth plate. UIMG No. 570, ×⅔.	
26-29.	**Odontaspis** sp. indet.	299
	Lateral denticles of anterior teeth. UIMG Nos. 571, 572, USNM Nos. 185595 and 185596, ×3⅓.	
30-35.	**Rhinoptera** sp. indet.	298
	30. Lower view, lateral tooth, UIMG No. 573; 31, 32. Upper and lower views of a tooth in middle series, UIMG No. 574; 33, 34, 35. Other denticles, UIMG No. 575, USNM Nos. 185597, 185598, all ×3⅓.	

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