

## Palynological and Age Determination of the Campano-Maastrichtian (Mamu Formation) Deposit of the Anambra Basin, Awgu Section, Southeast Nigeria

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D.O.I: [10.56201/ijaes.v10.no1.2024.pg50.72](https://doi.org/10.56201/ijaes.v10.no1.2024.pg50.72)

### Abstract

*An outcropping unit of the Mamu Formation in Awgu section was studied on the basis of its palynological assemblages and infer a biostratigraphic interpretation. Sediment samples obtained from the outcropping units of the Mamu Formation in the Anambra Basin, Awgu section was analysed for their palynological assemblages using the conventional maceration techniques for recovering of acid insoluble organic-walled microfossils from sediments. Lithological studies and physical description of the Formation was done in the field. The diagnostic palynomorphs recovered permitted the dating and biostratigraphic interpretation of the studied outcrop and this includes: Foveotriletes margaritae, Longapertites marginatus, Monocolpites marginatus, Mauritiidites lehmanii, Foveotriletes margaritae, Syncolporites marginatus, Proxapertites operculatus Echitriporites trianguliformis, Echitriporites trianguliformis, Proteacidites sigalii and Monocolpopollenites sphaeroidites. The results show that Mamu Formation was deposited during Late Campanian to Late Maastrichtian and the recovered palynomorphs was dominated by brackish to marine waters suggesting depositions within the shoreface to open marine thus giving rise to a lagoon-shallow marine environment.*

**Keywords:** Palynological, Age, Palynomorphs, Lithology, Anambra Basin

### 1. Introduction

Palynological studies entails the study of palynomorphs, mainly of spores and pollens grains. This spore and pollen grains are formed with sporangia (Heusser 1979). Most of the palynological characterization of the Mamu Shale in the Anambra Basin have so far been on a given locality. The need to carry out Palynological investigation of the Mamu Shale from a different locality where the outcrop is well exposed inspired this current research work. Several researches in the time past and current have carried out studies on the lithofacies and Palynology age determination of the Campanian-Maastrichtian Sedimentary fill of Anambra Basin. Those who had undertaken palynological studies of the Anambra Basin includes: Chiaghanam et al (2018), Nwajide and Reijers (1996), Obaje et al (1999) Umeji (2006), Onuigbo et al (2012), Soronnadi-Ononiwu (2012), Ogala et al (2009), chiaghanam et al (2012). Palynological characterization system of the Anambra Basin is emphasized on the application of palynological principles in correlating and dating of the various formation in the basin. The integration of data from palynomorphs will provide better interpretation.

This study will attempt to use palynostratigraphic approach that will utilize the derived palynomorphs from the sampled outcrop section to characterize the various lithostratigraphic units, decipher the age of the strata mapped in the field.

## **2. Regional Geology of the Study Area**

The Anambra basin is located in the southeastern part of Nigeria. The Anambra basin is bounded to the North by Bida basin and Northern Nigerian Massif, to the east by Benue Trough, to the west by African Massif, and to the South by Niger Delta complex. The basin is a Cretaceous basin having almost a roughly triangular shape with a total sediment thickness of about 40,000 sq.km. Anambra basin is characterized by enormous lithologic heterogeneity in both lateral and vertical extensions derived from a range of paleo-environmental settings, (Akaegbobi, 2009).

## **3. Geologic/Tectonic History of the Study Area**

The evolution history and regional tectonic setting of the study area is confined to the southern part of the Abakaliki - Benue Trough which began in the lower Cretaceous times, during the fragmentation of the continent over the globe leading to separation of the South America and Africa plates and the formation of basins in Nigeria. At least, two episodes of tectonics have been identified in the trough. During the Cenomanian time, it experienced a minor tectonic event, which resulted in uplift in the Northeast and South West directions as proposed by Nwachukwu (1972). The earlier Cenomanian episode affected only Albian sediments (Olade, 1975), the cause of the episode is temporary cessation of the mantle contraction. In Santonian time, an intensive tectonic event occurred. The Santonian phase affected all pre-santonian sediments within the depression. The Santonian tectonism terminated in the Turanian to Conacian marine depositional cycle in the Benue Trough. The Pre-santonian incomplete beds were folded, faulted intruded and uplifted to give rise to the Abakaliki - Okigwe Anticlinorium. The Abakaliki-Okigwe Anticlinorium Trends Southeast, North -West and is flanked on the west by the major Anambra basin and on the East by a smaller Afikpo basin. The Anambra basin became the major depositional centres. The Santonian tectonism changed the regional sedimentation pattern in the Abakaliki-Benue Trough from essentially Northeast-Southwest to the East west direction.

However, the cause of Santonian tectonic event according to Olade, (1975) was as a result of the reactivation of mantle upwelling in Turonian times with attendant mantle expansion and contraction.

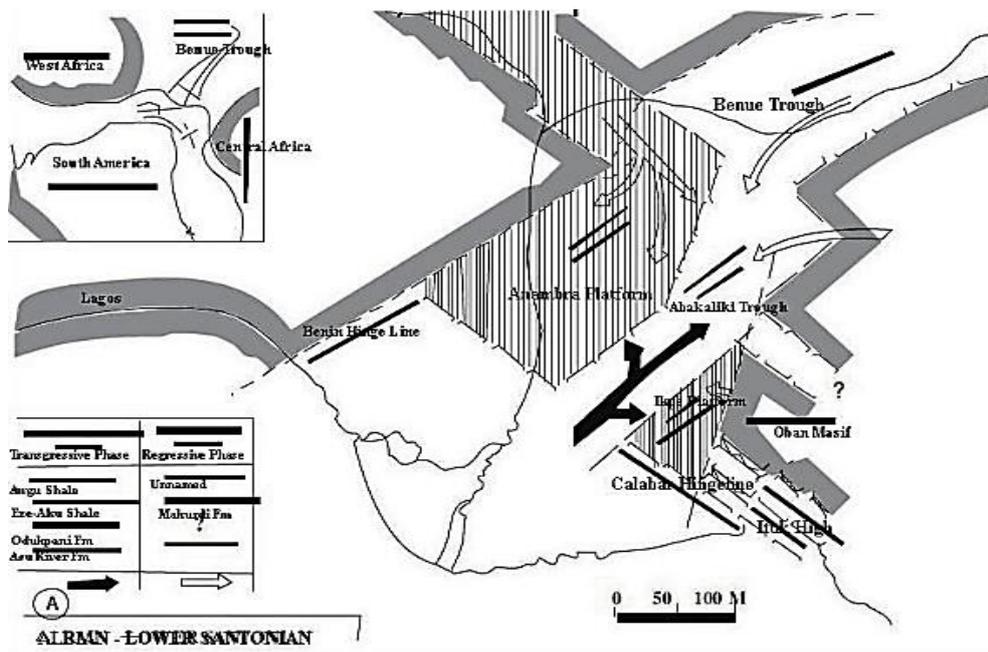


Fig.1:Tectonic map of southeastern Nigeria during Albian-Tertiary (adapted from Murat RC. 1970)

#### 4. Location and Accessibility of the Study Area

The area under study is located within the Anambra Basin. It lies between latitude  $06^{\circ}07'79''N$  and longitude  $007^{\circ}26'93''E$ . The Anambra Basin is one of the basin formed after the Santonian tectonism event that gave rise to the uplift of the Benue through, thereby creating depression in both flank of the uplifted Benue Trough. The study area exhibits a ridge and swell topography resulting mainly from the Santonian tectonic disturbance of the Benue through as earlier stated. The sandstones make up the ridges while the swell is occupied by shale and siltstones.

The study area is easily accessible by major and minor roads and foot paths. Due to the easy accessibility of the area, accessing the studied outcrop sections was not an issue.

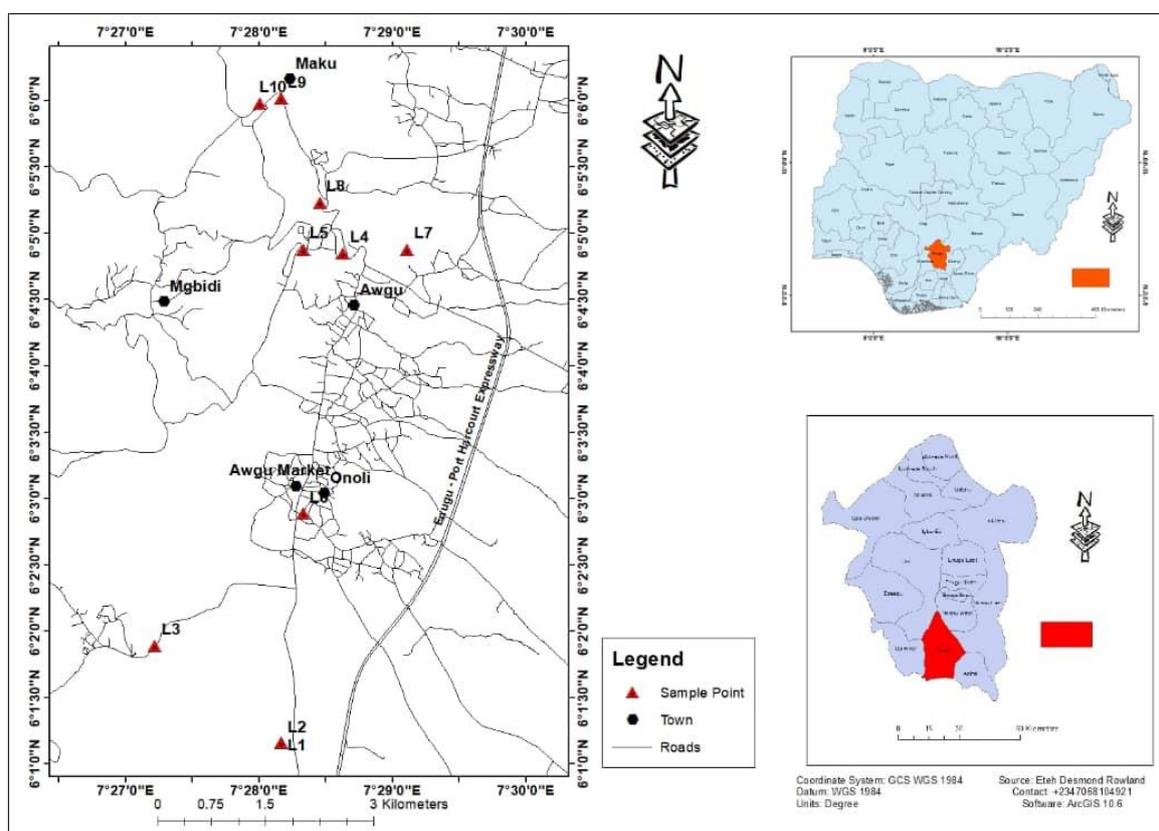


Fig. 2: Location Map of the study area

## 5. Materials and Methods

The outcrop sections of the Mamu Formation from different localities within the Awgu area were carefully studied and logged from the base to the top. Fresh samples of shales and heteroliths (mainly grey to dark grey) collected from different stratigraphic levels (bottom to top) on the outcrops of the formations were subjected to palynological analysis using the maceration method.

## 6. Biostratigraphic Sample Preparation:

Samples collected from the outcrops visited, were taken to the laboratory for palynological studies. The samples were pulverized, heated and soaked with Sodium hexametaphosphate in distilled water following the standard non-mineral acid palynological sample preparation method. The soaked samples were centrifuged with zinc chloride at 2.0 specific gravity as heavy liquid to allow for floating of the palynomorphs. The floated palynomorphs were washed using 5microns mesh sieve size and mounted in palynological slides with cover slip using optical adhesive. The samples were also prepared for foraminifera studies following the standard foraminifera preparation method. The samples were pulverized, soaked with sodium bi-carbonate and washed using 63microns mesh sieve size, under a running tap with distilled water. The residue consisting of mineral grains were allowed to dry on a gentle heat using enamel plates. The dried mineral grains were separated into fine, medium and coarse fractions to ease analysis using 150microns and 250microns mesh sieve sizes.

## 7. Biostratigraphic Sample Analysis:

The prepared palynological and foraminiferal samples were analysed using transmitted light and stereo microscopes respectively. While the palynological sample preparation yielded palynomorphs, no recoveries of foraminifera were made on the foraminiferal sample preparations indicating complete barren in foraminifera. This may be the effect of poor preservation, slow burial or as a result of scavenging micro-organisms on foraminifera occurrences.

The relative abundance of each miospore was recorded in terms of specimens per field of view (FOV) and categorised as present (P), Rare (R), frequent (F), common (C), and abundant (A) according to Styzen (1997) cascading counts of fossil abundance. In this study, miospores counts between 1 to 5 is Rare, 6 to 35 is Frequent, 76 – 150 is common and 301 – 600 is Abundant. Data generated from the palynological analysis yielded rare to frequent occurrence of miospores. The quality of preservation of the recovered miospores does not permit taxonomical classification to species levels for most of the miospores. Only very few of the miospores were identified to species levels, others whose preservation are relatively poor are identified to their generic level.

## 8. Results and Discussions

### 8.1 Palynostratigraphy:

The palynostratigraphy of the study area were determined based on the palynofloral occurrences from the analysed samples. The samples consist of two locations and the palynofloral assemblages identified include:

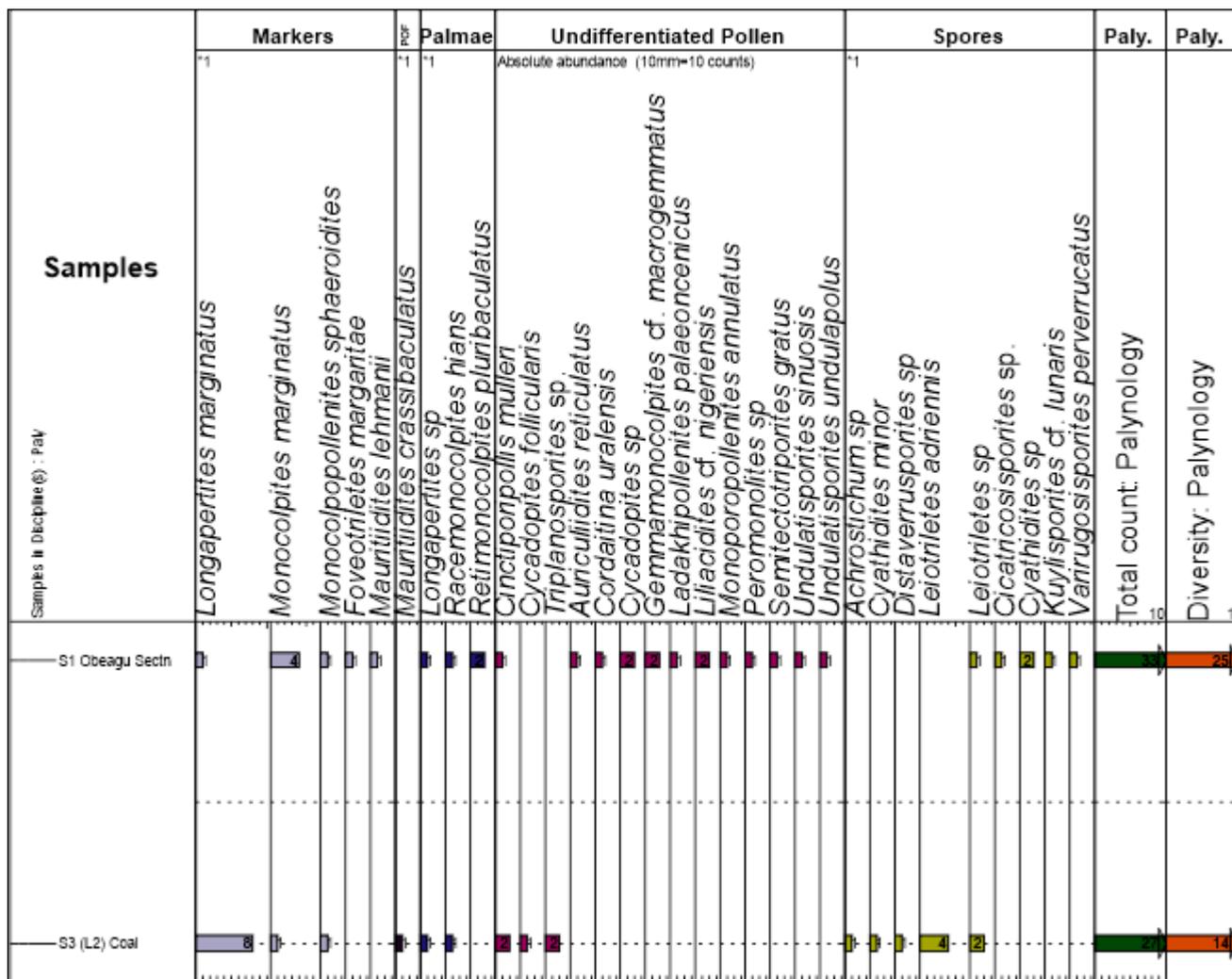
### 8.2 Location: Location: Ugwe-Ise Archi Road (Mamu Formation)

This location consists of two sampled points (sample 1 section and sample 2). Miospores identified in this location outcrop samples are rare in occurrences with species abundance between 1 – 4 occurrence (rare) in most identified miospores and a single frequent occurrence of *Longapertites marginatus* in sample 2, with a total abundance of 8 occurrences. Miospores in sample 1 of this location are rare in occurrence with only one species occurring at a frequency of 1.

A palynofloral assemblage with a total abundance of 1 occurrence from a diversity of 1 species was identified in sample 1 Obeagu section while 27 occurrences from a diversity of 14 species was identified in sample 2 Carbonaceous shale.

The miospores identified include, (*Classopollis classoides*, *Peromonolites* sp., *Racemonocolpites hians*, *Retimonocolpites pluribaculatus*, *Semitectotriporites gratus*, *Undulatisporites sinuosis*, *Undulatisporites undulapolus*, *Varirugosisporites perrucatus*, *Cyathidites minor*, *Leiotriletes adriennis*, *Triplanosporites* sp., *Achrostichum aureum*, *Cycadopites follicularis*, *Distaverrusporites* sp., and *Mauritiidites crassibaculatus* (Fig. 2).

Ugwe-Ise-Archi road sample II palynofloral assemblage consists of a total abundance of 27 occurrences from 14 miospores, while only 1 miospore (*Classopollis classoides*) was identified from sample 1.



**Fig.3:** Palynological distribution chart of Mamu formation outcro at Ugwe-Ise-Archi road

### 8.3 Location: Obeagu (Mamu Formation)

Obeagu location consists of two samples (sample 1 and Obeagu II sample). The diversity of miospores occurring in sample 1 Obeagu section is relatively high. Miospores in Obeagu II sample is rare in occurrence, and occur within the range of 1 to 3.

A palynofloral assemblage with a total abundance of 33 occurrences from a diversity of 25 species was identified in sample 1 Obeagu section. frequencies in most of the identified species with one species (*Longapertites marginatus*) occurring at a frequency of 7 (Frequent). The miospores include *Cinctiporipollis mulleri*, *Longapertites marginatus*, *Monocolpites marginatus*, *Cicatricosisporites sp.*, *Cordaitina uralensis*, *Cyathidites sp.*, *Cycadopites sp.*, *Foveotriletes margaritae*, *Kuylisporites cf. lunaris*, *Gemmamonocolpites cf. macrogemmatus*, *Gemmamonocolpites macrogemmatus*, *Ladakhipollenites palaeoncenticus*, *Leiotriletes sp.*, *Liliacidites cf. nigeriensis*, *Longapertites sp.*, *Mauritiidites lehmanii*, *Monocolpopollenites sphaeroidites*, *Monoporopollenites annulatus* *Longapertites marginatus*, *monocolpites marginatus*, *Leiotriletes adriennis*, *Laevigatosporites discordatus*, *Cinctiporipollis mulleri*, *Laevigatosporites josensis*, *Longapertites discordis*, *Retitrescolpites cf. splendens*, *Retitrescolpites cf. splendens* and *Triplanosporites microsinosus* (fig. 3)

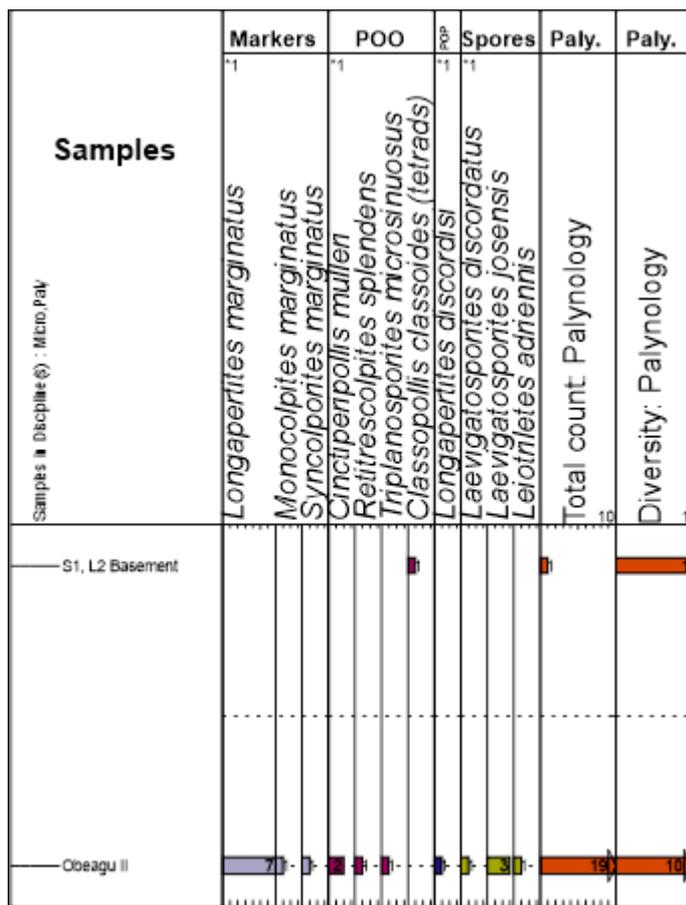


Fig. 4: Palynological distribution chart for Obeagu outcrop

#### 8. 4 Age Determination/Biozonation of studied Samples:

The age of the formation from where the samples were taken were determined based on the marker species identified in the prepared and analysed samples. Trend in biostratigraphic events such as first appearance and last appearance datum, quantitative base and quantitative top as well as continuous occurrence events could not be ascertained because of the mode of sampling (spot sampling). Presence of marker species were applied to salard-cheboldaeff (1990) and used in determining the age, while the biozonation was determined by applying the ages determined based on presence of marker species to the pantropical zones of Germeraad et al., 1968.

#### 8.5 Mamu Formation at Ugwe-Ise Achi Road

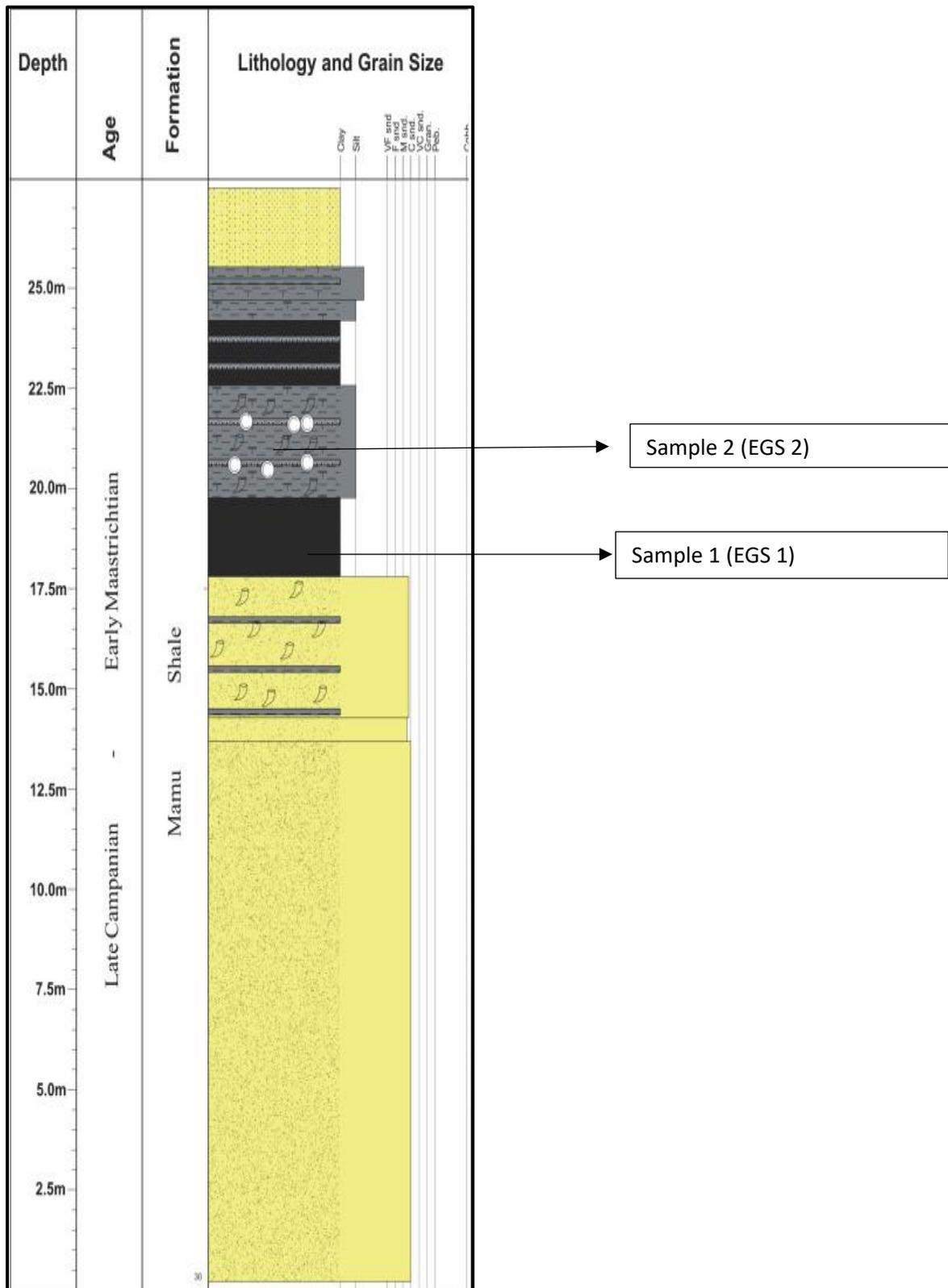
Playnological analysis of sample collected from Mamu Formation along Ugwe-Ise Archi Road, Archi shows that the age range is btween Early Campanian (based on FAD of *Leiotriletes Sp*, *Monocolpites Marginatus*, *Cyathidites Minor* and *Distaverrusporites Sp*) and Late Maastrichtian (based on LAD of *Leiotriletes Sp* and *Leiotriletes adriennis*).

Stratigraphic range of markers identified in Ugwueme sample include *Leiotriletes Sp* with first appearance datum (FAD) in Early Campanian and last appearance datum (LAD) in Late Maastrichtian; *Leiotriletes adriennis* with first appearance datum (FAD) in Middle Campanian and last appearance datum (LAD) in Middle Maastrichtian; Longapertites Marginatus with first

appearance datum (FAD) in Late Campanian and last appearance datum (LAD) in Late Maastrichtian; *Monocolpites Marginatus* with first appearance datum (FAD) in Early Campanian and last appearance datum (LAD) in Late Maastrichtian; *Momocolpopollinites Sphaeroidites* with first appearance datum (FAD) and last appearance datum (LAD) in Early Maastrichtian; *Longapertites Sp* with first appearance datum (FAD) in Late Campanian and last appearance datum (LAD) in Early Maastrichtian; *Mauritiides Crssibaculatus* with first appearance datum (FAD) in Early Maastrichtian and last appearance datum in Late Maastrichtian; *Cyathidites Minor.* with first appearance datum (FAD) in Early Campanian and last appearance datum (LAD) in Late Maastrichtian; *Distaverrusporites Sp.* with first appearance datum (FAD) in Early Campanian and last appearance datum (LAD) in Late Campanian.

Essentially, the presence of *Leiotriletes adriennis* which indicated Late Campanian - late Maastrichtian, *Leiotriletes adriennis*, *Longapertites sp* which indicated late Campanian – Early Maastrichtian, and *Hystrichodinium pulchrum* which indicated Early Maastrichtian is more precise because *Cyathidites minor* is a long ranging.

Therefore, the formation may be said to have been deposited during Late Campanian to late Maastrichtian.



**Fig. 5: Sampling points of Mamu Formation at Ugwe-Ise Achi Road**

Table 1: Palynomorph species as analyzed in sample picked from outcrop section along Ugwe-Ise Archi Road Sample II

<b>Palynomorphs</b>	<b>Relative Abundance</b>
<i>Triplanosporites microsinosus</i>	2
<i>Longapertites marginatus</i>	8
<i>Monocolpites marginatus</i>	1
<i>Leiotriletes sp</i>	2
<i>Longapertites sp</i>	1
<i>Monocolpopollenites sphaeroidites</i>	1
<i>Racemonocolpites hians</i>	1
<i>Cyathidites minor</i>	1
<i>Leiotriletes adriennis</i>	4
<i>Triplanosporites sp.</i>	2
<i>Achrostichum aureum</i>	1
<i>Cycadopites follicularis</i>	1
<i>Distaverrusporites sp</i>	1
<i>Mauritiidites crassibaculatus</i>	1

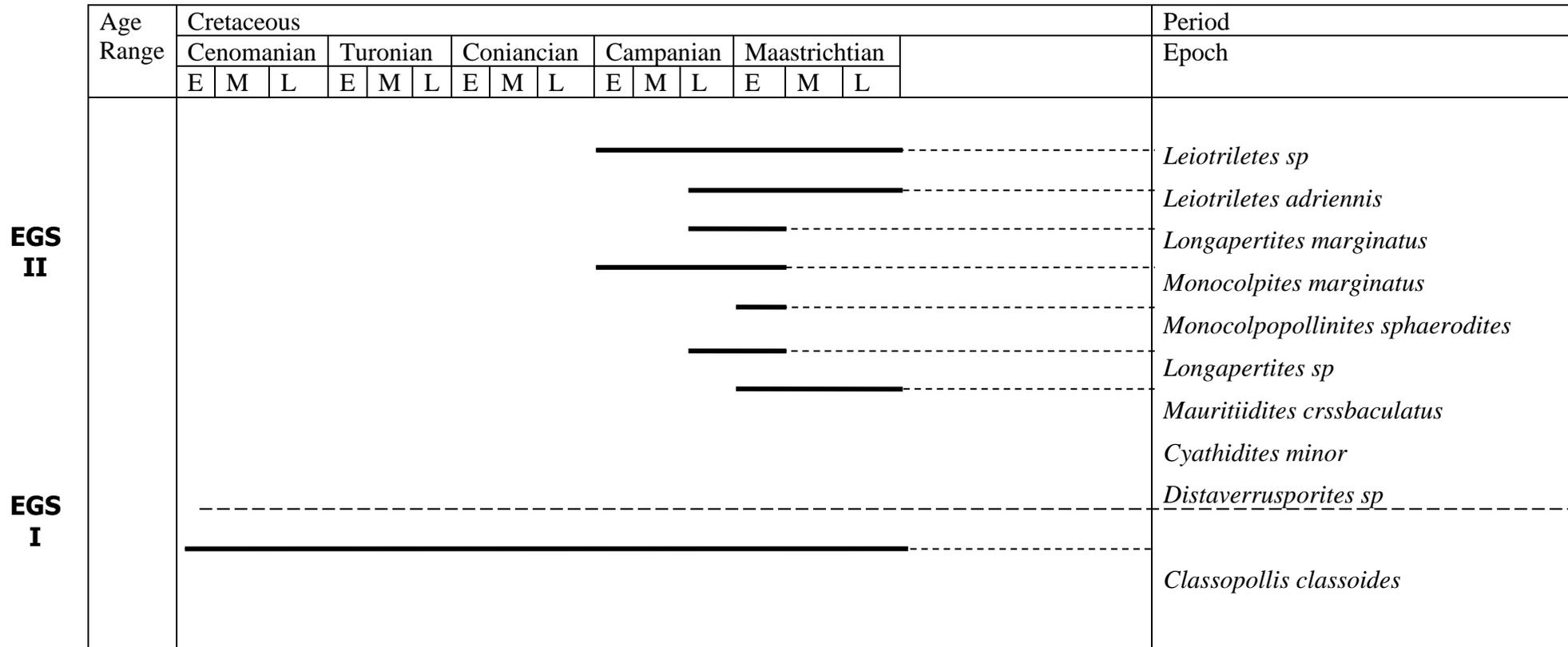


Fig. 6: Distribution Chart of Recovered Palynomorphs from Achi-Mmaku Road (Coal/Carbonaceous Shale)

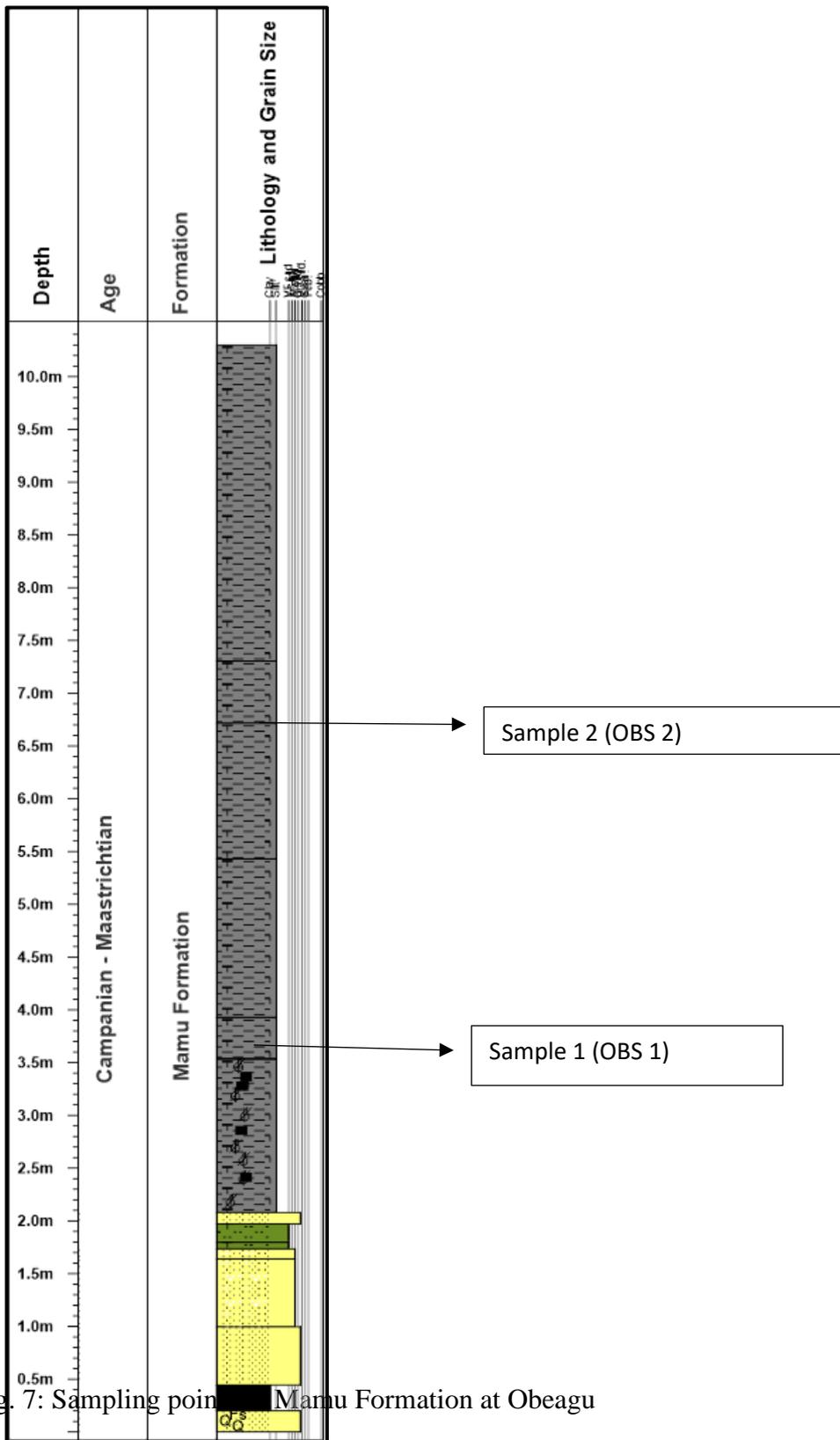


Fig. 7: Sampling points in Mamu Formation at Obeagu

### 8.6 Mamu Formation at Obeagu (Sample 1)

The age range of Mamu Formation in Obeagu sample I is between Early Turonian (based on FAD of *Mauritidites lehmanii*) and Late Maastrichtian (based on LAD of *Leiotriletes sp*, *Lilacidites cf. nigerienis*, *Auricutiides reticulates*, *foveotriletes margaritae*).

Stratigraphic range of markers identified in Obeagu sample I include *Leiotriletes sp* with first appearance datum (FAD) in Early Campanian and last appearance datum (LAD) in Late Maastrichtian; *Lilacidites cf. nigerienis* with first appearance datum (FAD) in Early Maastrichtian and last appearance datum (LAD) in Late Maastrichtian; *Longapertites Marginatus* with first appearance datum (FAD) in Late Campanian in datum (LAD) in Early Maastrichtian; *Cyathides sp* with first appearance datum (FAD) in Early Coniancian and last appearance datum (LAD) in Early Maastrichtian; *Monocolpites marginatus* with first appearance datum (FAD) in Early Campanian and last appearance datum (LAD) in Early Maastrichtian; *Monocolpopollinites sphaeroidites* with first appearance datum (FAD) and last appearance in Early Maastrichtian; *Longapertites sp* with first appearance datum (FAD) in Late Campanian and last appearance datum (LAD) in Early Maastrichtian; *Auricutiides reticulates* with first appearance datum (FAD) in Early Campanian and last appearance datum (LAD) in Late Maastrichtian; *Mauritides lehmanii* with first appearance datum (FAD) in Early Turonian and last appearance datum (LAD) in Late Maastrichtian; *Cycadopites sp* with first appearance datum (FAD) in Late Campanian and last appearance datum (LAD) in Early Maastrichtian; *Foveotriletes margaritae* with first appearance datum (FAD) in Early Campanian and last appearance datum (LAD) in Late Maastrichtian

Essentially, the presence of *Longapertites marginatus*, *Longapertites sp*, *Cycadopites sp* which indicated Late Campanian to Early Maastrichtian *Monocolpopollinites sphaeroidites* which indicated Early Maastrichtian and *Lilacidites cf. nigerienis* which indicated Early to Late Maastrichtian is more precise because *Auricutiides reticulates* and *Cyathidites sp* are long ranging.

Therefore, the Formation may be said to have been deposited during Late Campanian to Late Maastrichtian

### 8.7 Mamu Formation at Obeagu (Sample 2)

The age range of Mamu Formation in Obeagu sample II is between Early Campanian (based on FAD of *Monocolpites Marginatus*, *Syncolporites Marginatus* and *Laevigatosporites discordatus*) and Late Maastrichtian (based on LAD of *Leiotriletes adriennis* and *Leiotriletes adriennis*).

Stratigraphic range of markers identified in Obeagu sample II of Mamu Formation include *Leiotriletes Adriennis* with first appearance datum (FAD) in Late Campanian and last appearance datum (LAD) in Late Maastrichtian; *Longapertites marginatus* with first appearance datum (FAD) in Late Campanian and last appearance datum (LAD) in Early Maastrichtian; *Monocolpites Marginatus* with first appearance datum (FAD) in Early Campanian in datum (LAD) in Early Maastrichtian; *Syncolporites Marginatus* with first appearance datum (FAD) in Early Campanian and last appearance datum (LAD) in Late Maastrichtian; *Syncolporites Marginatus* with first appearance datum (FAD) in Early Campanian and last appearance datum (LAD) in Late Campanian

Essentially, the presence of *Leiotriletes adriennis* which indicated Late Campanian – Late Maastrichtian and *Longapertites marginatus* which indicated Late Campanian to Early Maastrichtian is more precise because they are not long ranging.

Therefore, Mamu Formation may be said to have been deposited during Late Campanian to Late Maastrichtian

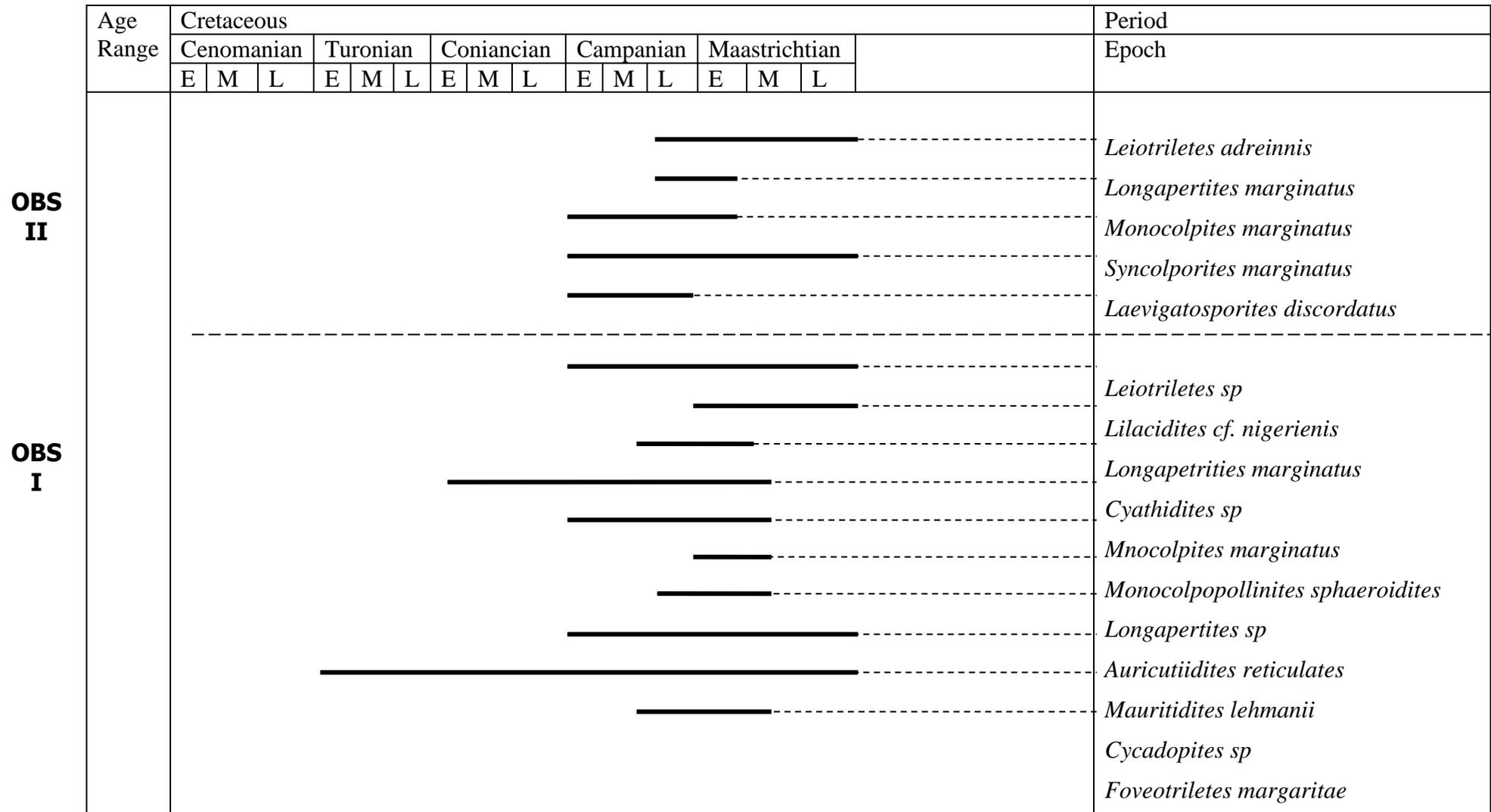


Fig. 8: Distribution Chart of Recovered Palynomorphs from Obeagu Sample (Mamu Formation)

Table 2: Palynomorphs species as analyzed in sample I picked from Obeagu

Palynomorphs	Relative Abundance
<i>Cinctiporipollis mulleri</i>	1
<i>ongapertites marginatus</i>	1
<i>Monocolpites marginatus</i>	4
<i>Auriculiidites reticulatus</i>	1
<i>Cicatricosisporites sp.</i>	1
<i>Cordaitina uralensis</i>	1
<i>Cyathidites sp</i>	2
<i>Cycadopites sp</i>	2
<i>Foveotriletes margaritae</i>	1
<i>Gemmamonocolpites macrogemmatus</i> cf.	1
<i>Gemmamonocolpites macrogemmatus</i>	1
<i>Kuylisporites cf. lunaris</i>	1
<i>Ladakhipollenites palaeoncenicus</i>	1
<i>Leiotriletes sp</i>	1
<i>Liliacidites cf. nigeriensis</i>	2
<i>Longapertites sp</i>	1
<i>Mauritiidites lehmanii</i>	1
<i>Monocolpopollenites sphaeroidites</i>	1
<i>Monoporopollenites annulatus</i>	1
<i>Peromonolites sp</i>	1
<i>Racemonocolpites hians</i>	1
<i>Retimonocolpites pluribaculatus</i>	2
<i>Semitectotriporites gratus</i>	1
<i>Undulatisporites sinuosus</i>	1
<i>Undulatisporites undulapulus</i>	1
<i>Varirugosisporites perrucatus</i>	1

Table 3: Palynomorphs species as analyzed in sample II picked from Obeagu

Palynomorphs	Relative Abundance
<i>Leiotriletes adriennis</i>	1
<i>Laevigatosporites discordatus</i>	1
<i>Cinctiporipollis mulleri</i>	2
<i>Laevigatosporites josensis</i>	3
<i>Longapertites discordis</i>	1
<i>Longapertites marginatus</i>	7
<i>Monocolpites marginatus</i>	1
<i>Retitrescolpites cf. splendens</i>	1
<i>Syncolporites marginatus</i>	1
<i>Triplanosporites microsinosus</i>	1

## 9. Conclusion

The stratigraphic range of the identified markers in the study samples were used for the biozonation of the studied samples. The zone is characterized by *Foveotriletes margaritae*, *Longapertites marginatus*, *Monocolpites marginatus*, *Mauritiidites lehmanii*, *Foveotriletes margaritae*, *Syncolporites marginatus*, *Proxapertites operculatus* and *Echitriporites trianguliformis*, first appearance and continuous occurrence of *Echitriporites trianguliformis*, and continuous occurrence to last appearance datum of *Proteacidites sigalii* and *Monocolpopollenites sphaeroidites*. This corresponded to the *Proxapertites operculatus* pantropical zone of Germeraad et al. (1968).

A palynomorph distribution chart was produced showing the assemblage distribution of palynomorphs. The age of the studied interval was suggested using the palynological information obtained from the samples. The age was determined to be Early Campanian to Middle Maastrichtian of the presence of *Trichotomosulcites sp 1* Which indicated Early Campanian, *Batiacasphaera spp 1* and *Kallosphaeridium yorubease* which indicated Early – Late Campanian, *Longapertites* which indicated middle - late Maastrichtian. The plots show that the palynomorphs were dominated by terrestrial forms. The depositional system of the Mamu Formation ranges from Delta plain to Delta front and Lagoonal environment suggesting a marine environment.

## Acknowledgement.

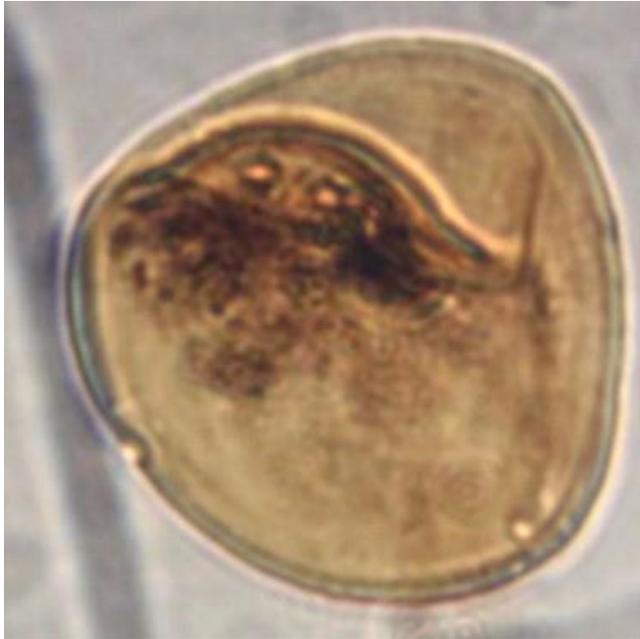
This paper is part of Ph.D dissertation under the supervision of Prof. Ajaegwu N. E., Nnamdi Azikiwe University, Awka, Anambra State, Nigeria. The author is most grateful to the second author for providing all the necessary assistance for the success of this work.

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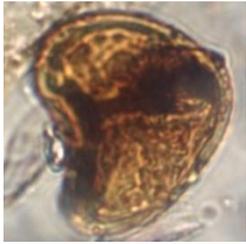
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## APPENDIX



Classopollis classoides

### Plate 1. Palynomorphs from Ugwe-Ise Sample 1



Achrostichum aureum



Triplanosporites sp.



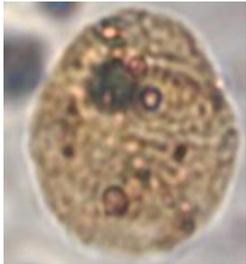
Triplanosporites sp. (2)



Cyathidites minor



Cycadopites follicularis



Distaverrusporites sp



Leiotriletes adriennis



Leiotriletes adriennis (2)



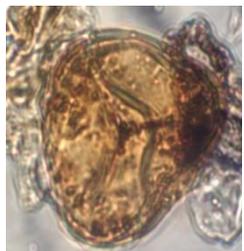
Leiotriletes adriennis (3)



Leiotriletes adriennis (4)



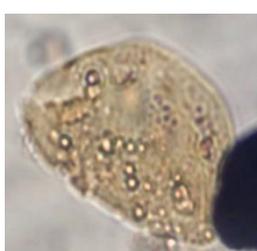
Leiotriletes sp



Leiotriletes sp (2)



Longapertites marginatus



Longapertites marginatus (2)



Longapertites marginatus (3)



Longapertites



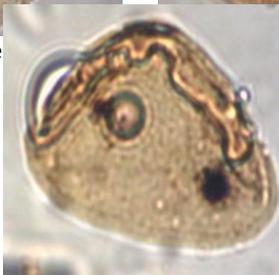
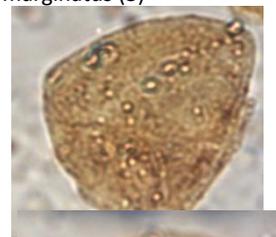
es marg



argin



tus (7)



Longapertites sp.



Mauritiidites crassibaculatus



Monocolpites marginatus



Monocolpopollenites sphaeroidites



Racemonocolpites hians



Triplanosporites sp.



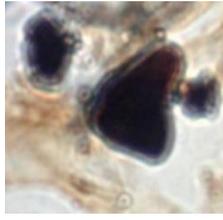
Triplanosporites sp. (2)



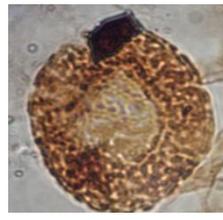
*Auriculiidites reticulatus*



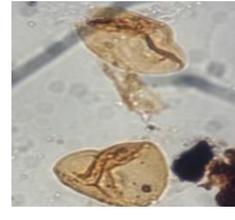
*Cicatricosisporites* sp.



*Cinctiporipollis mulleri*



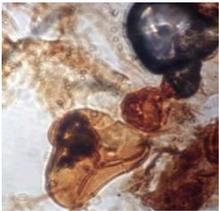
*Cordaitina uralensis*



*Cyathidites* sp (2)



*Cyathidites* sp



*Cycadopites* sp (2)



*Cycadopites* sp



*Foveotriletes margaritae*



*Gemmamonocolpites* cf. *macrogemmatus*



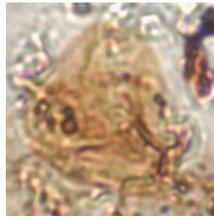
*Gemmamonocolpites macrogemmatus*



*Kuylisporites* cf. *lunaris*



*Ladakhipollenites palaeoncenicus*



*Leiotriletes* sp



*Liliacidites* cf. *nigeriensis* (2)



*Liliacidites* cf. *nigeriensis*



*Longapertites marginatus*



*Longapertites* sp



*Mauritiidites lehmanii*



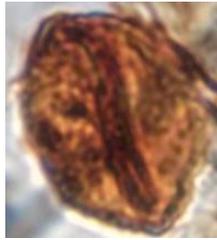
*Monocolpites marginatus* (2)



*Monocolpites marginatus* (3)



*Monocolpites marginatus*



*Monocolpites marginatus*



*Monocolpopollenites sphaeroidites*

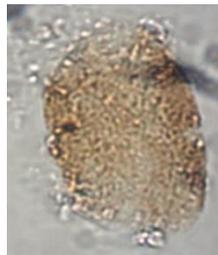
**Plate 3: Palynomorphs from sample 1 in Obeagu Section of Mamu Formation**



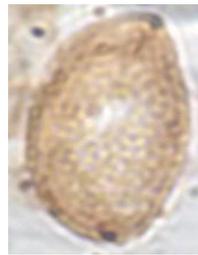
*Monoporopollenites annulatus*



*Peromonolites* sp



*Racemonocolpites hians*



*Retimonocolpites pluribaculatus* (2)



*Retimonocolpites pluribaculatus*



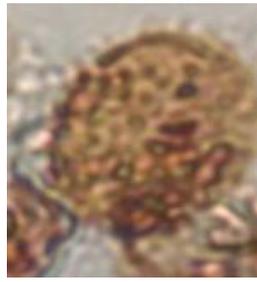
*Semitectotriporites gratus*



*Undulatisporites sinuosis*

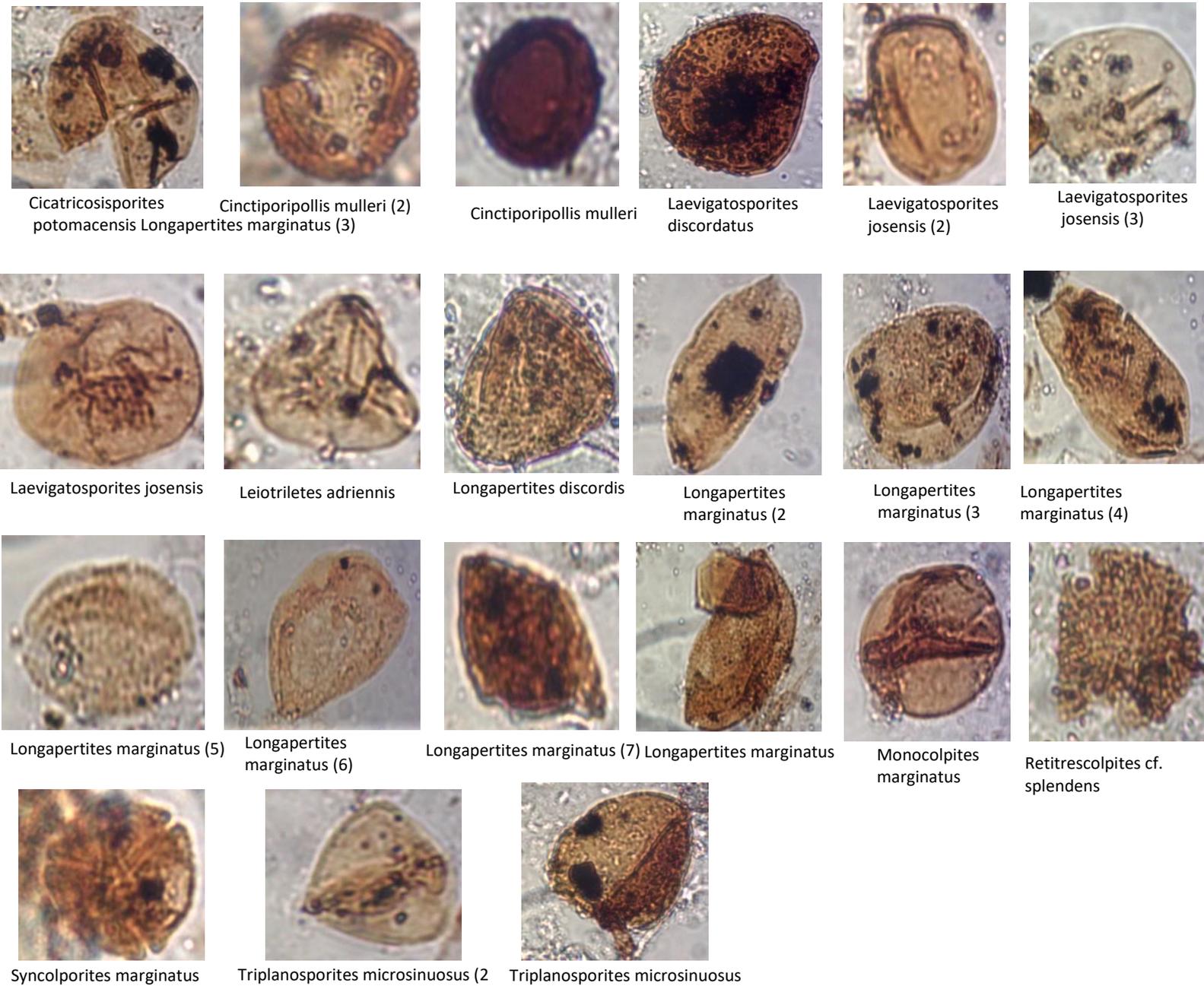


*Undulatisporites undulapulus*



*Varirugosisporites perverrucatus*

**Plate 4: Palynomorphs from sample 1 in Obeagu Section of Mamu Formation**



**Plate 5: Palynomorphs from sample 2 in Obeagu Section of Mamu Formation**