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Research Article

PALYNOLOGICAL BASELINE DATA ACQUISITION OF THE MIDDLE ANDLOWER BENUE TROUGH, NIGERIA.

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ABSTRACT

Palynological Baseline data acquisition for superficial sediments were carried out within the Middle and Lower Benue Trough in the area bounded by longitudes 6.49E and 8.33E and latitudes 4.47N and 8.35N. The study area traverse from Lafia Nasarawa State to Emohua town Rivers State. Samples collected comprises sandstone, siltstone and shale across a geographic spread of the study area. The palynologic analysis yielded *Nympheapollis clarus*, *Fenestrites spinosus*, *Cyperaceapollis sp* and *Stereisporites sp*. *Echitricolpites spinosus, Fenetrites spinosus*; from middle Benue Trough. *Echimonocolpites rarispinosus, Cingulatisporites ornatus, Macrotyloma brevicaules, Tubistephanocolpites cylindricus, Hexaporotricolpites emelianova, Retidiporities magdalenensis, Retistephanoclpites gracillis, Elaeis guineensis*; from Lower Benue Trough. *Retitriporitesheterobrochati*, *Aspleniumsporites trivedii*, *Retistephanocolpites gracillis*, *Elaeis guineensis*, *Echitricolporites spinosus*, *Multiareolites formosus* and *Matonisporites sp* , *Multiarolites formosus,* from Benin Formation. The identification of these palynomorphs helped to generate a percentage distribution paleogeographic chart showing the occurrences of the different palynomorph groups; pollen, spore, dinoflagelate, fungal spore, acritarch ,foram test wall linining, and diatom. Seven biozones were recognized which was marked by the introduction of two or more new species across the paleogeographical distribution chart and attempt was made at the reconstruction of the paleoecology for the zones. First to Fifth zones (*Elaeis guinnensis, Echitricolporitesspinosus*, *Polydopollenitesp*, *Proceatidite sp* , *Proceatidite longispinosus* respectively) which are characterized by fresh water swamp.The Sixth and seventh zones consists of the *Cycadocolpites sp* zoneand *Psilatricolporites sp* zone indicating a mangrove vegetation.

INTRODUCTION

Most palynological studies in Nigeria in the past four and a half decades were primarily based on the needs of the oil industry. Because of the occurrence of hydrocarbon in the Niger Delta, oil companies carried out most of the works on the Niger Delta and information from them has remained confidential. Few published studies exist on the Niger Delta, among which are those of Burke 1972 and Avbobo. Most of the above listed studies are largely concerned with systematic descriptions of pollen and spores, or palynological zonations based primarily on foraminiferal assemblages and litho and bio-stratigraphy. The reconstruction of past environments is one of the goals of palynological research and this entails the study of the periodic changes in environment over geological time. This offers another way of studying the climatic changes of the past. The changes in climate are most evidently reflected in the vegetation. This is because the vegetation of any area is an integral and basic component of the ecosystem and is sensitive to changes in the ecosystem. According to Ivanor *et al*. (2007), the distribution pattern of vegetation strongly depends on climatic conditions and thus vegetation reconstructions help to understand past climates. Sowunmi (1987) reported that a close relationship exists between vegetation and the rest of the environment, particularly climate and soil. Thus, the flora of an area, generally speaking, provides a good reflection of the major climatic regime of that area. The influence of climate on other components of the environment is so great that every particular climatic zone has its own characteristic vegetation type. Therefore, plants are among the best indicators of the environment especially of the climate, soil and fauna. Therefore the basis of this research work is based on the fact that certain individual or assemblages of plants that are known to be characteristic of specific ecological zones and the occurrence of the fossils of such ecological indicator species in sediments is considered a reflection of contemporary ecological conditions.

(a) Aims of the study: The Aim of this study is to generate a data base of palynomorphs within the study area and by extension to provide palynological databaseline for forensic studies

(b) Location of the study area: The coordinates of the study areas range from longitudes 6.49E and 8.33E and latitudes 4.47N and 8.35N. (Figure 1.)

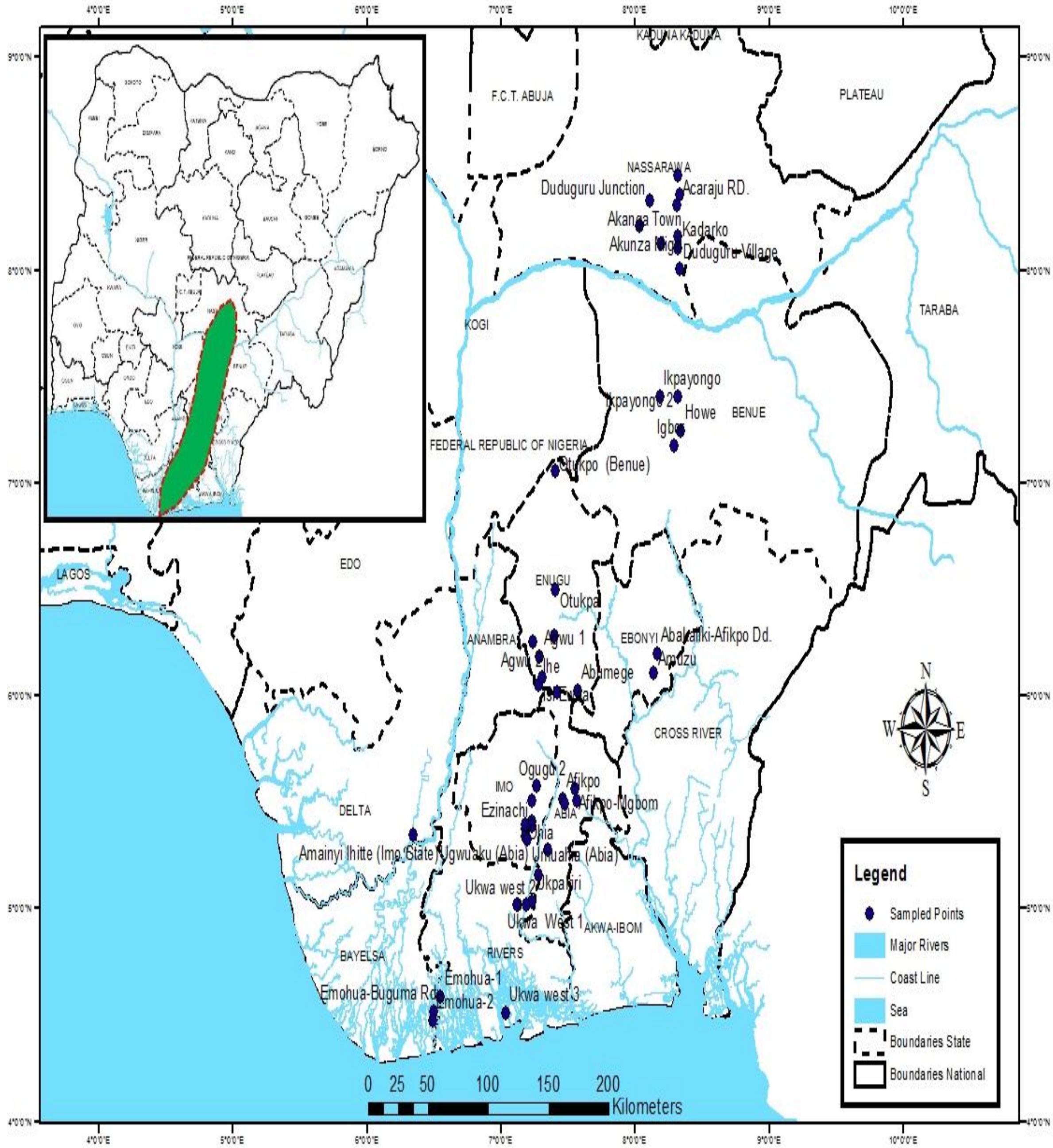


Figure 1: Location map of the study area showing the sampled points.

(c) Literature review: Several authors have made various studies on the Benue Trough and Niger Delta among which are those of Zaborski (1983) on the Chronostratigraphic paleoecologic studies that have been carried out on various Cretaceous sequencess of the Benue Trough using ammonites. Oloto (1984) described the late Cretaceous and Tertiary sediments from the Gbekebo – 1 well making use of dinoflagellates cysts with pollen and spores assemblage encountered for the dating.

Oyelaran (1991) reported that paleoenvironmental reconstruction has so far made modest progress in Nigeria. Elsewhere in Africa, several studies exists documenting vegetation and climatic changes at various geologic periods especially in the Holocene (Sowunmi, 1981a, 1981b; Jahns *et al*., 1998; Salzaman, 2000; Marchant and Taylor, 2000). However, very few palynological studies have been carried out detailing Tertiary paleonvironmental changes especially in Nigeria but none of these studies have been done on forensic palynology.

METHODOLOGY

(A) SAMPLE COLLECTION:

The field work was carried out with the aid of some basic instruments such as road map, Global Positioning System (G.P.S), digital camera, marker, field notebook, pencil, eraser, masking tape, sample bags (used to collect samples from different locations) (See Plate 1-4). Hand auger and hand trowel was used to collect both surface and sub-surface samples (few meters deep). A total number of 51 control samples were collected using the “pinch” method (Adams and Mehringer, 1975): collecting 10 pinches of soil throughout each sampled locations of about 50 to 100 square meters. These pinches were combined into a single, sterile, plastic bag and then sealed. Multiple pinches from each sample area were combined to prevent the possibility of over-representation of a single pollen type. The samples collected from different locations were well-labelled with sample and location number and then kept in a sample bag. The hand auger and hand trowel were washed thoroughly with water to ensure samples remain contamination-free (Bryant *et al*., 1990) through all stages of collection and storage until the analysis are over. It is also necessary to note that samples were collected from fresh and undisturbed vegetations that has not experienced bush burning, farming or contains construction materials

Plate 1: Samples were collected with the use of a hand auger.

Plate 2: Several pinches of samples collected with a hand auger were well-labelled and stored in a sample bag.

Plate 3: Weathered shale sample exposed at Lokpanta. The shale is hard, light to dark grey and fissile.

Plate 4: Samples collected from the thick mangrove swamp along Emohua – Buguma road yielded palynomorphs that showed a change in variation along the geographic spread in the studied locations.

(B) PALYNOLOGICAL PROCEDURE:

(a) **Palynological Sample Preparation:**Two to three grams of the samples were broken to a grain size of 4mm, and transferred to a plastic breaker cup. The beakers were then labeled according to the depth of the samples. All the samples were then treated with commercial grade hydrofluoric acid. The essence of these was to separate the fossils from the rock debris. Most of the calcareous samples showed effervescence.The length of time needed for the samples to digest varies depending on the quantity of silt and sand. But once the initial heat of reaction had been dissipated, hydrofluoric acid concentration was increased. The samples were displaced in a water bath and stirred, with plastic rods twice a day for the period of maceration. The effect of the acid was neutralized by decanting and settling method.The residual rock particle and megafossils were separated from the finer disaggregated material by passing them through a mesh of 106μm and 200μm. The filtrate was thoroughly washed with water using the 10μm mesh nylon sieve. The subsequent residue was swirled on a 24cm diameter watch glass. The lager residual was discarded while the final top material was boiled for a few seconds in water to which a few drops of concentrated hydrochloric acid was added. The residual was again washed in the 10μm mesh nylon sieve and stained with safranin- O in a mild alkaline medium stored in small glass centrifuge tubes and labeled.

(b) Slide preparation: The stained specimen above is further diluted and washed out with water and the finished residual transferred into a tube with two drops of diluted solution of glue is added. A few of the residual is pipetted out on a clean dry cover slip, allowed to dry on a hot plate. Canada balsam is smeared on a slid on a hot plate at 1000C. When warmed enough, the dried cover slip was stuck to the slide, pressed uniformly to avoid air bubble and allowed to dry. The prepared slide is cleaned, labeled correctly and properly stored after cooling.

(c) Examination of sample: Tschudy (1969), recommended steps to be followed, in this study the preliminary examination of the prepared material followed by a quantitative listing of the pollen and spore flora were carried out. Secondly, a quantitative determination of the dominant palynomorphs present was done. In carrying out the first step, the essence is to yield or provide information as to the reliability of the sample. If the sample is reliable, the most useful information normally gained is a record of the total composition of the flora. This will give clue as to the knowledge of the range in time of specific taxa, floral origin, evolution and the nature of facies and the climate at the time of deposition. Whereas, quantitative determination provides information on the dominate palynomorphs, base on absolute figures, percentages or both. In determining the relative abundance, identification and counting was continued until all the samples were exhausted under high as well as low, power microscope and results recorded .Depths where palynomorphs were encountered are analyzed and identified.

RESULTS AND INTERPRETATIONS

The results have been separated into Lithology, Percentage distribution of the palynomorphs, Pollen assemblage zones and Paleoecology.

(i) LITHOLOGY: The lithological and textural characteristics were derived by the use of hand lens and physical examination. It was characterized by sandstone and siltstone with the sand grains exhibiting fine to coarse grained size. They were well to moderately sorted, minor rootlets. The sand grains sub-angular to sub-rounded and light to dark grey in colour. The siltstone contains a significant fraction of clay .(Figure 2)

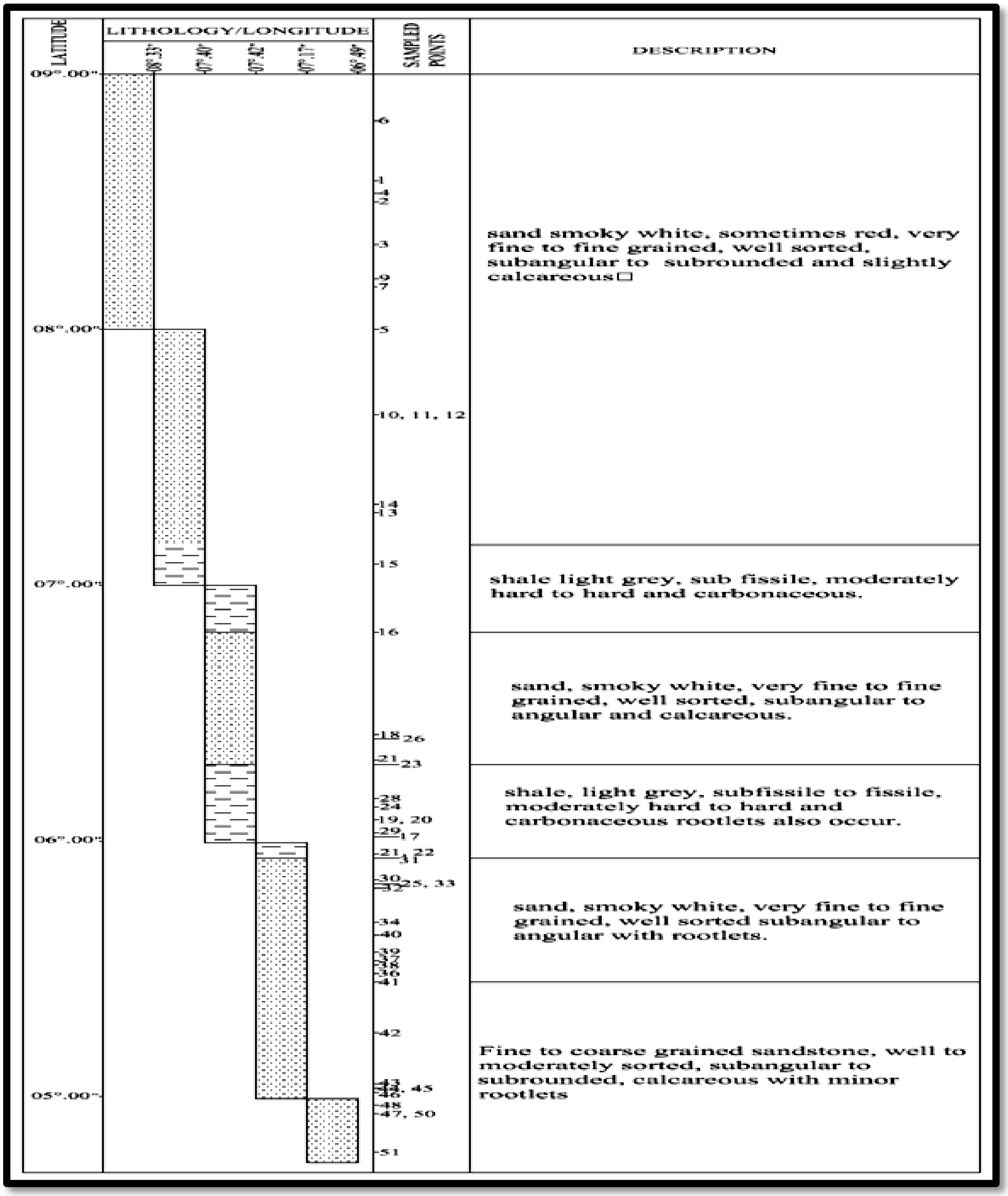
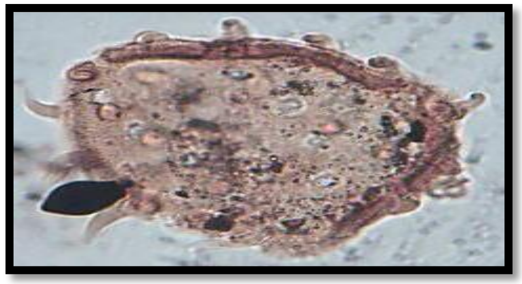
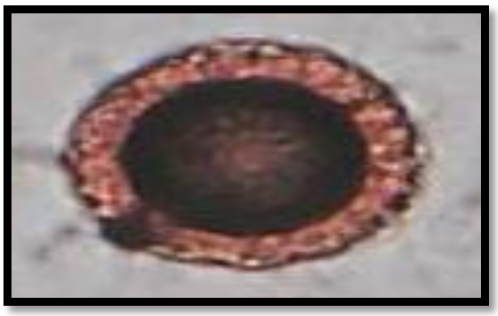


Figure 2: Lithology of the Studied Sample.

(a) Fungal spore



(b) polyadopollenites, sp



(c) Cycadopites, sp

(d) Zonocostites ramonae

(e) Leiotriletes sp

(f)Cingulatisporitessp

(g) Laevigatosporitesdiscordatus

(g) Echitricolpites spinosus

Plate a-g: SOME OF THE PALYNOMORPHS ENCOUNTRED IN THE STUDY AREA

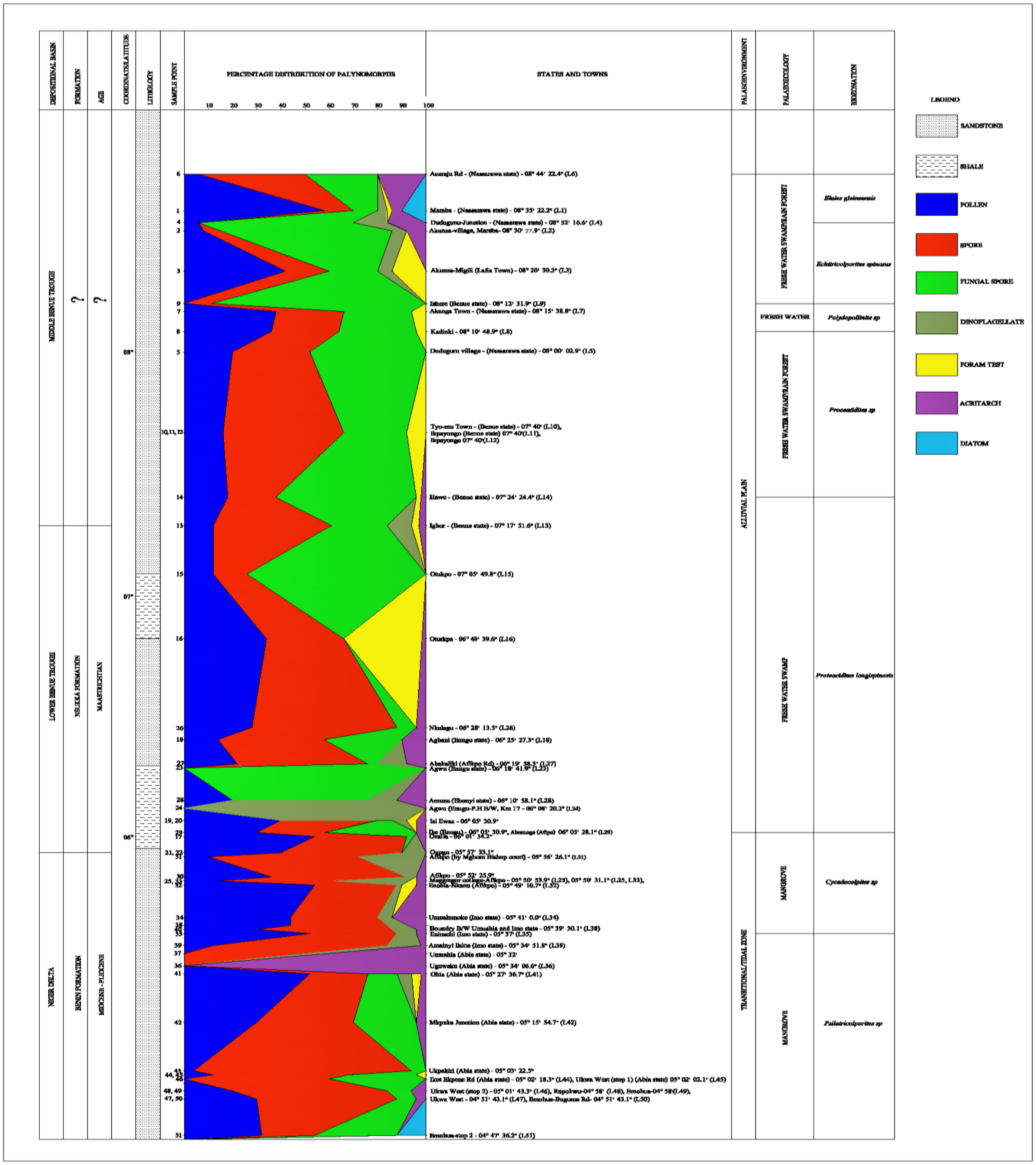


Figure 3: Shows a representation of the percentage distribution of palynomorphs generated from the seventeen (101) samples that were collected in a lateral geographic trend from the study area.

(ii) POLLEN ASSEMBLAGE ZONES:

The evolution of organisms through time provides the framework for a system of zonation by which discrete units of time represented by accumulation of sediments can be recognized. A segment of a stratigraphic record that is characterized by particular species of index fossils may be formally recognized as a zone. Some zones are defined by the presence of single specie while others are distinguished by the presence of two or more species. A zone is generally named for a species that characterizes it. It receives its name from one or more of these fossils. The basis for recognizing assemblage zones include; variations in the fossil taxa, abundance of specimens or both. The assemblage zone may indicate ecologic facies, age or both. The pollen and spore diagram in (fig 3) showed the most important taxa for different locations of the study area. The recognized assemblage zones are discussed under previously recognized major zones According to marked vegetation change reflected in the pollen diagram (Germeraad, Hopping and Muller, 1968). These have been classified according to their paleoecological zone and thus consider being ecologically significant the species were not ubiquitous, but belonging to distinct ecological zones. Furthermore they have been identified to species level or to types identifiable with species. The zonation for Paleoecology is as follows;

Zone I: *Elaeis guineensis*

Locations 1-5

Definition: Species first appearing at the base of the zone – *Zonocostites ramonae, Monoporites annulatus, Echnimonocolpites, Retitricolporites sp, Multiareolites formosus, Magnaperiporites spinosus. Psilatricolporites operculatus, Psilatriporites sp and indeterminate pollen.*Species first appearing at the top of the zone – *Nympheapollis clarus, Retisphenanocolpites gracillis and Echiperiporites sp.* Species last occurring within the zone –*Indeterminate pollen*. Species last occurrence at the top of the zone – *Echiperiporites sp*.

Remark: Base of the zone is marked by abundance of *Zonocostites ramonae.* Increase in abundance of grass pollen(*Monoporites annulatus*) within the zone. Rich in Pteridophyte spores towards base of the zone and presence of *Elaeisguineensis* pollen.

Zone II: ***Echitricolporites spinosis***

Locations 6- 8

Definition: Species first appearing at the base of the zone – *Echnitricolporites spinosi and Peregrinipollis nigericus.*Species last occurring at the top of the zone – *Cyperaceapollis sp, Polydopollenites, Brevicolporites guinetti*

Remark: This zone contains relatively low palynomorphs. The base is marked by absence of *Zonocostites* *ramonae.* Increase abundance of *Psilatriporites and abundance of fungal spore marks in* zone IV.

Zone III:*Polydopollenites sp*

Locations 8 – 9

Definition: Species first appearing at the base of the zone – *Cyperaceapollis sp, Polydopollenites, Brevicolporites guinetti.* Species last occurring within the zone – *Synocolporites, indeterminate pollen and Psilatriporites.* Species last occurring at the top of the zone – *Gramminaecuticle, Aletepollenites sp, Psilastephanocolporites sp, Psilamonocolpites sp, Striatricolpites catatumbus*

Remark: This zone is characterized by the presence of *Cyperaceapollis sp* and a slight decrease in *Multiareolites formosus.* It is relatively low in pteridophyte spore

Zone IV:*Proteacidites sp*

Locations 10 – 14

Definition: Species first appearing at the base of the zone – *Proteacidites sp, Echitriporites spinosus, Fenestrites spinosus.* Species last occurring at the top of the zone –*Echitricolporites spinosis and Peregrinipollis nigericus.*

Remark: This zone is characterized by gradual decrease in *Zonocostites ramonae, Psilatricolporites sp* within the zone. It shows abundance in fungal spore.

Zone V : Family -*Proteaceae*

Location 15-19

Definition: Species first appearing at the base of the zone; *Psiladiporites nnewiensis, Retidiporites rarispinosus, Syndemicolpites sp, Adenantherites sp, Macrotyloma brevicacule, Proteacidites longispinosus, Constructipollenites ineffectus, Echitriporites triangulifromis, Monocolpites sp, Porocolpopollenites sp, Proxapertites, Tubistephanocolpites cylindricus, Haxaporotricolpites emelianova, Psilatricolpites sp, Auriculiidites reticulates, Baculatriporites orluensis, Proteacidites miniporatus, Longapertites sp, Ephedripites sp*
Species first appearing at the top of the zone; *Echiperporites sp, Zonocostites ramonae, Nympheapollis clarus.*
Species last occurring at the top of the zone; *Echiperporites sp*
Remark: Very rich in palynomorphs assemblage, it showed a slight increase in pteridophyte toward the top base defined a quantitative increase of *Adenanatherites sp, Proteaciditie*s *longispinosus and Echitriporites trianguliformis* pollen.

Zone VI:*Cycadocolpites sp*

Location20- 34

Definition: Species first appearing at the base of the zone – *Fenestrites sp, Cycadocolpites sp, Podocarpidites.*

Species last occurring at top of the zone - *Proteacidites sp, Echitriporites spinosus, Fenestrites spinosus.*

Remark: Abundance of *cycadocolpites sp,* abundance ofpteridophytes spores and thezone is marked by a decrease in fungal spore.

Zone VII:*Psilatricolporites sp*

Locations 35 – 51

Definition: Species first appearing at the base of the zone – *Psilatricolporites sp, Multiareolites sp.* Species last occurring within the zone – *Retitricolporites sp, Nympheapollis clarus, Aletepollenites sp, Acanthacea sp, Echiperiporites sp, Retitricolpites sp, Psilatricolporites sp, Multiareolites sp.* Species last occurring within the subzones – *Elaeis guineensis, Psilastephanocolporites sp, Echitricolporites sp.* Species last occurring at the top of the zone – *Fenestrites spinosus, Multiareolites formosus, Praedapollis flexibilis, Echitriporites sp.*.

DISCUSSION OF RESULT

ZONE I:

The high percentages occurrence of pollen and spores show that vegetation was well established during the period covered by the location thus conforms to the terrestrial paleoenvironment. This conclusion was further strengthened by the high percentage occurrence of *Elaeis guineensis* pollen of fresh water elements in the zone. Other vegetation community in existence during this period is the presence of *Nympheapollis clarus* that represent the savanna elements. The increasedccurrence of fungal spores in this zone supports the suggestion that conditions were adverse during this period.

ZONE II:

The predominant vegetation during the period covered by this zone was fresh water as indicated by the predominance of *Echitricolporites spinosus, Brevicolporites guinetii.* Furthermore, a reduced representation of mangrove vegetation confirmed the zone to be of fresh water vegetation. The minor alteration of *Monoporites annulatus* (grass pollen) further inland with the ground covered by pteridophytes probably reflects the shifting boundary between forest and savannah in the lowlands..

ZONE III:

Few species of pollen and spore are found in this zone and few species of *podopollenite sp, absence of fungal spore is noted*. The presence of *concentricyst circulus*shows or indicates the infiltration of fresh water into the depositional environment. The presence of *podopollenite sp* confirms ecological zones to be fresh water

Zone IV:

These high percentages of *Proteaceae* pollen indicate that freshwater swamp/rain forest was well established during this period and that there was a rise in sea level with the freshwater swamp/rainforest being dominant over the alluvial plain. Furthermore, the representation of freshwater swamp rainforest suggests their continued existence during this period. The climatic inference deducible from this zone is that the climate was wet and warm.

Zone V:

This period is covered by a high percentage of *proteacidites longispinosus* and *Retitricolpites sp* indicating fresh water rainforest vegetation was well established during the period. There was an initial rise in sea level with the mangrove vegetation increasing in extent. Subsequently, there were variations in sea level leading to changes in the intensity and extent of the tides into and out of bays, estuaries and other restricted coastal openings. These oscillations in sea level were likely to have caused fluctuations in the percentage occurrence of *Zonocostites ramonae.* This zone corresponds to the alluvial plain paleoenvironment due to the abundance of fresh water rainforest elements.

Zone VI:

The high percentages occurrence of *cycadocolpites sp* in this zone was an indication that mangrove swamp vegetation was well established during the period covered by the location, thus conforms with the transitional paleoenvironment. It also shows that there was a rise in sea level with the coast predominantly taken over by *cycadocolpites sp* . As far as the *Rhizophora* pollen type is unique and cannot be confused with pollen from other taxa (cf. also Muller, 1964). This conclusion was further strengthened by the very low percentage occurrence of *Elaeis guineensis* pollen of fresh water elements in the zone. Other vegetation community in existence during this period is the presence of *Fenestrites spinosus*, *Multiareolites formosus* that represent the savanna elements. The increased occurrence of fungal spores in this zone supports the suggestion that conditions were adverse during this period. Fungal spores are a means of surviving unfavourable environmental conditions.

Zone VII:

There was a drop in the percentage occurrence of *psiltricolsporites sp* in this zone, mangrove vegetation was still in predominant. A lower but probably relatively stable sea level prevailed during this period. A good representation of pteridophytes and fresh water swamp forest vegetation was also in existence. Hence a transitional (tidal zone) paleoenvironment is inferred to this zon

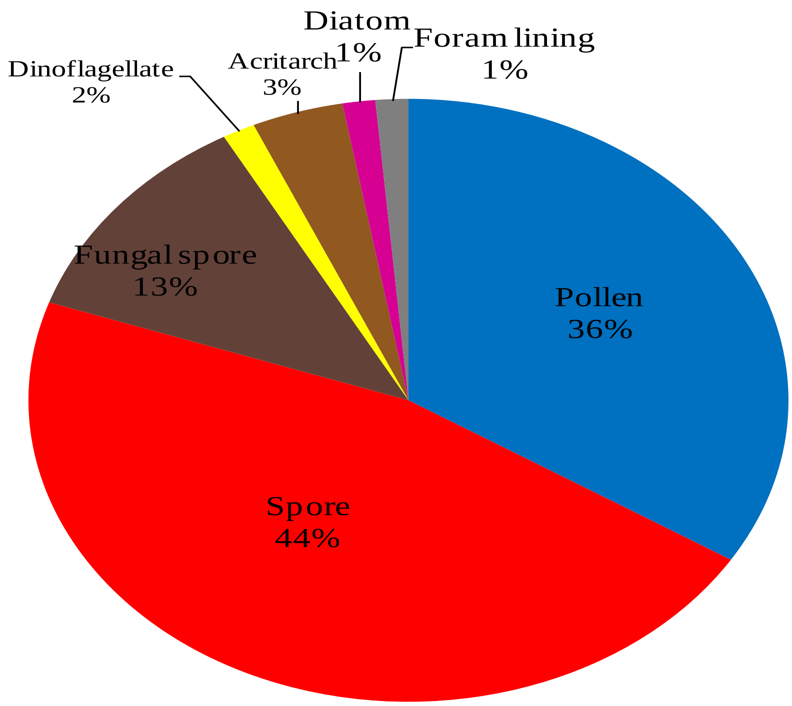


Figure 4: Percentage occurrence of Palynomorphs in the Study Area

CONCLUSION

Accordingly, the most primary aim of this research work is to generate a baseline data of palynomorphs within the study area for forensic investigations in Nigeria. It also shows that palynologic record and the environment have a direct relationship with respect to vegetation and climate. The result of this work indicate that a total number of 51 samples which were collected across a geographic spread from north to south which yielded a range of palynomorphs assemblage data. The distribution of palynomorphs varied considerably from one geographic location to another. Pollen and spores preservation was good in most of the samples and the microflora was rich and well diversified. The total number of palynomorphs counted per sample ranged from 3 to 221 with the lowest abundance at sample 25 and the highest abundance at samples 21 and 22.

The pollen and spores were gradually increasing from the north to south across the latitudinal geographic spread. Seven biozones were drawn from the results and the paleoecology infers fresh water to mangrove swamp vegetation. Zones VI and VII are marked by an abundance of mangrove pollen (*Cycadocolpites* and *Psilatricolporites sp* respectively) with an increased occurrence of fungal spores in the zones. Hence, a Paleoecology for this zone is mangrove. In zones I,II, III, IV, and V, there is abundance in *Elaeis guineensis ,Echitricolporites spinosus*, *Polydopollenite sp, Proceatidites sp, and proceadities longispinosus,* respectively. These zones are therefore confined to the fresh water swamp Paleoecology.

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