Palynostratigraphy and paleoecology of chev-1 well, southwestern Niger delta basin, Nigeria
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ABSTRACT
Twenty five ditch cutting samples from southwest Niger Delta basin were analysed to determine the palynostratigraphic studies. The samples contained very rich and diverse palynomorphs dominated by pollen grains which consist of 12 species distributed among ten genera. Pollen preservation is good with concentration ranging from 1,640 to 34,900 grains/g. The stratigraphic ranges of Circulina parva, Monoporites annulatus, Psilatricolporites operculatus, Multiareolites formosus, Zonocostites ramonae, Podocarpus milanjianus, Echitricolporites spinosus, Retibrevitricolporites obodoensis, R. protrudens and Retitricticopites bendensis and some other marker species were used to demarcate nine palynozones in the study area. These palynomorphs are mainly made up of mangrove swamp floras which suggest the predominance of a high sea level and wet climatic condition in Miocene-Pliocene during the deposition of the studied sediments.

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Fig. 1 Sedimentary Basins in Nigeria Showing the Niger Delta Basin and well location (Modified from Whiteman10, Benkheli11).

Materials and Method of Study
Twenty five shaly samples taken at 60 ft interval from CHEV-1 well (3130-6031f) in the offshore section of the western Niger Delta, Nigeria were subjected to palynological treatment. Standard maceration technique (Faegri and Inversen12, Wood et al.13) was followed in the preparation of these samples. Samples were treated with HF and HCl to remove calcareous and siliceous materials respectively; heavy liquid separation using zinc chloride and hydrochloric acid solution (specific gravity 2.0) and finally acetylsis to dissolve cellulose for easy identification of palynomorphs. Minor modifications such as varying the percentage of hydrochloric acid (30-36%) used, staining of some residues and excluding acetylsis step for older samples with no cellulose. After treatment, samples were mounted on slides and studied under x40 and x100 objective using an Olympus CH30, camera-attached microscope. Photomicrographs of the most important palynomorphs were taken.
Results and Discussion

Palynological Assemblage

Rich and diverse assemblage of palynomorphs species was recovered. In general, pollen preservation in the analyzed sediments is good (Plate 1) and concentrations are high, ranging from 1,640 to 34,900 grains/g. The assemblage consists of pollen (74%), spores (3%), indeterminate species (1%) and fungal spores (22%).

The recovered palynomorphs in this study is dominated by angiospermous pollen. The angiosperms consist of several species of Stephanoporites, Echitricolpites, Echiperiporites, Monocolpites, Tricolpites, Dicolpites, Breitbrevitricolpites and Monoporites (see chart).

Palynostratigraphy

Eighty percent of the recovered palynoflora association encompasses palynomorphs that are of Late Miocene-Pliocene age (Germerraad et al., Morley and Richards). Some of these palynomorphs are Circulin parva, Monoporites annulatus, Psilatricolpites operculatus, Multiareolites formosus, Zonocostites ramonae, Podocarpus milanjianus, Echitricolpites spinosus, Retitretricolpites obodoensis, R. protrudens and Retitricolpites bendensis. These and others are used to study the palynostratigraphy of the studied well.

The palynostratigraphic analysis was based on the works of Evamy et al., Richards and Morley and Morley17. The informal zones recognised are designated as JM and JP, meaning “Jide Miocene” and “Jide Pliocene” respectively (see Table 1 and Chart). The zones are:

JM1 Zone (5,800 – 6,030 ft): P800 zone, subzone P850, Late Miocene.

The base of the zone is expediently marked at 6,030 ft since it is the base of the analyzed interval in the well. The top is marked by the absence of Monoporites annulatus (Poaecae) at 5,800 ft and uphole increase of Sapotaceae. The zone is characterized by low occurrence of Monoporites annulatus and abundance of Multiareolites formosus.

JM2 Zone (5,700-5,800 ft): P800 zone, subzone P850; Late Miocene.

The base is placed at 5800ft, at the first appearance of Sapotaceae and the absence of Monoporites annulatus while the top was recognized at 5,700 ft by the first appearance (base occurrence of Circulin parva (Nymphaea lotus) and quantitative base of Monoporites annulatus. The quantitative first appearances (basas) of Sapotaceae and Pachydermites diederiixi characterize this zone.

JM3 Zone (5,300-5,700 ft): P800 zone, subzone P860; Late Miocene.

The base is at 5,700 ft based on the first appearance of Circulin parva and the quantitative base of Monoporites annulatus. The top was recognized at 5,300ft by the base occurrence of Retitricolpites obodoensis (Borreria sp.) and downhole increase of Monoporites annulatus. This zone characterised by the acme of Zonocostites ramonae (Rhizophora sp., Retistephanocolpites gracilis and Multiareolites formosus. Other diagnostic forms are Psilatricolpites crassus and Echitricolpites spinosus.

JP1 Zone (5,000-5,300 ft): P800 zone, subzones P870-P880; Early Pliocene.

The base occurrence of Retistephanocolpites gracilis at 5,300 ft and downhole increase in Monoporites annulatus mark the base of this zone. The top at 5,000 ft was marked by the base occurrence of Retitricolpites bendensis. The peculiarity of the zone is, the first appearance of Retitricolpites obodoensis; significant occurrence of Retitretricolpites protrudens, Sapotaceae and quantitative event of Psilatricolpites spp.

JP2 Zone (4,700-5,000 ft): P800 zone, subzones P870-880; Early Pliocene.

The base was recognized at 5,000 ft by the first appearance of Retitricolpites bendensis while the first appearance of Podocarpus milanjianus at 4,700 ft marks the top of the zone. High occurrence of Zonocostites ramonae, occurrence of Echiperiporites estalae and Psilatricolpites spp. characterize the zone.

JP3 Zone (4700-4600 ft): P800, Late Pliocene.

The first appearance of Podocarpus milanjianus at 4,700 ft and the uphole decrease in the occurrence of Sapotaceae at 4,600 ft mark the base and the top of this zone respectively. The uphole decrease of Zonocostites ramonae and the high occurrence of Leotriletes spp. are the unique characteristic of the zone.

JP4 Zone (4,600-4,250 ft): P900, Late Pliocene.

The base was recognized at 4,600 ft by uphole decrease in Sapotaceae while the last appearance of Retitretricolpites obodoensis at 4,250 ft mark top. Uphole increase of Zonocostites ramonae and high occurrence of Retitretricolpites obodoensis characterize the zone.

JP5 Zone (4,250-3,400 ft): P900 zone; Late Pliocene.

The first appearance of Retitretricolpites obodoensis at 4,250ft marks the base while the top was recognized with the last appearance of Retitricolpites bendensis. High occurrence of Monoporites annulatus and the fluctuating occurrence of Zonocostites ramonae; the first appearances of Retitricolpites bendensis, Retitretricolpites protrudens and Breitbrevitricolpites guineti are the uniqueness of this zone.

JP6 Zone (3,400-3,150 ft): P900 zone; Late Pliocene.

The base is at 3,400 ft where Retitretricolpites bendensis last appeared. The top of this zone may be shallower than the top of the analyzed interval. Since the zone belongs to the youngest of Evamy et al. zones, the abundance of Podocarpus milanjianus enabled the tentative placing of the top of this zone at 3,150 ft.

Contemporary angiospermous palynomorphs of Eocene and Oligocene ages such as Pachydermites diederiixi and Echiperiporites estalae together with the fern spore, Verucatosporites usmensis (Germerraad et al.) were also recovered. The rare occurrence of Late Cretaceous Spinizonocolpites baculatus and Racemonocolpites hians (Germerraad et al.) pollen grains was probably due to the reworking of the older Anambra basin sediments and their subsequent deposition in the Niger Delta basin. The recognised zones correlated well with P900 and P800 of Evamy et al. Three of the P800 subzones were demarcated using the base occurrences of Circulin parva (Nymphaea lotus) and Retitretricolpites gracilis. The recovered foraminifera species from these samples by the second author showed that JM1 to JM3 correlates with N17 of Blou (16, 19, JP1 to JP4 with N17-N18 and JP5 to JP6 with N18-N19.

Paleoenography

Paleoenvironmental reconstruction is usually hampered by gaps in the stratigraphic record and inability to observe and measure most features of ancient environments directly. This leads most workers to, according to Raup and Sepkoski19, rely on partial reconstruction of environments by stratigraphical and...
sedimentological techniques. Therefore, in making paleoenvironmental reconstruction, it is important to determine how representative the fossil palynomorphs are, bearing in mind the differential pollen production and preservation (Havenga). Hence the paleoecological deduction in this work was based largely on the palynomorphs with known Nearest Living Relatives (NLR) (Poumoit; Morley). This is because Paleogene and younger plant fossils often represent vegetation communities faithfully; older records can be difficult to interpret paleoecologically (Jacobs).

The environment of deposition of the studied sediments was dominated by mangrove swamp. Zonocostites ramonae (Rhizophora sp.), a mangrove species, whose high productivity in the coastal-continental shelf sediments. Therefore, in making paleoecological groups in the studied sediments indicate a high sea level and wet climatic condition (Feakins, et al.; Urrego, et al.).

Conclusion
Sediments from CHEV-1 well were subjected to palynological analysis. The study shows the sediments contained very rich, diverse and well preserved palynomorphs that were in most cases identified to the species level. The recovered marker species such as Zonocostites ramonae, Psaltricolporites operculatus, pachydermites diederixi, Retibrevitricolporites obodoensis and R. protrudens indicate the predominance of high sea level and wet climatic condition in the southwestern Niger Delta basin in Miocene-Pliocene during the deposition of the sediments.

Plate 1


Systematic palynology
Division sporoites h. Potonie. 1893.
Class Monoletes IBRAHIM 1933.
Verrumonoletes usmensis VAN DER HAMMEN, 1956, p.116, fig.7.
Verrucatosporites usmensis GERMERAAD et al., 1968, p. 290, pl. 3, fig. 3.

Description: Verrucate spore, single grain, bilaterally symmetrical, anisopolar with convex distal outline and straight or slightly concave proximal outline, ellipsoidal in polar view. Laevula monoleta.

Comment: This species has a larger laesura than that of GERMERAAD et al., 1968.

Botanical Affinity: Stenochnelaenapalastris, Phleboodium aureum.
Age: Late Eocene.

Division pollenites r. Potonie. 1931.
Class Monoporatae INVERSEN et TROELS SMITH, 1950.
Monoporites annulatus VAN DER HAMMEN, 1954, p.90, pl.6, fig.4.
Monoporites unipertusus VAN DER HAMMEN 1956b, p.82, pl.5, fig.10.
Monoporites annulatus GERMERAAD et al., 1968, p.292, pl.III, fig.3.

Description: Psilate pollen, single grain, radially symmetrical, anisopolar, almost spherical. Single, circular penetrating pore with annulus.

Comment: This species’ annulus is smaller than that of GERMERAAD et al., 1968.

Botanical Affinity: Poaceae (Gramineae)
Age: Eocene/Miocene.

Class Stephanoporatae INVERSEN et TROELS SMITH, 1950.
Genus Pachydermites GERMERAAD et al., 1968
Pachydermites diederixi GERMERAAD et al.1968, p.315, pl.X, figs.2.

Description: Psilate, stephanoporate pollen. Single grain, with 5 rather irregularly shaped less distinct pores. Endexine finely perforated around the pores, covered with a thin tectate-psilate ectexine. Radially symmetrical, isopolar and oblate-suboblate. Outline circular in polar view. Interior surface is irregularly verrucate.

Botanical Affinity: Symphonia globulifera.
Age: Mid-Eocene.

Class Periporatae INVERSEN et TROELS SMITH, 1950.
Genus Echiperiporites VAN DER HAMMEN et WYMSTRA, 1964.
Echiperiporites estelae GERMERAAD et al., 1968, p.315, pl. X, fig. 1.

Description: Stephanoporate pollen; single grain, centro-symmetrical, isopolar, spherical; densely spinose, periporate pores 20-24.

Botanical Affinity: Thespesia populnea (Malvaceae), Hibiscus tiliaeus (Malvaceae).
Age: Oligocene.

Class Monocolpatae INVERSEN et TROELS SMITH, 1950.
Genus Spinizonocolpites Muller, 1968.
Spinizonocolpites baculatus MULLER, 1968.
Spinizonocolpites echinatus group GERMERAAD et al., 1968, p.293, pl.IV, figs.2,3.

Description: Echinate pollen, single grain, radially symmetrical, slightly anisopolar, suboblate-spherical. Covered by a thin coarser reticulate tectum. Baculae scattered on tectum are straight with rod-like tips.

Botanical Affinity: Nypa fruticans.
Age: Late Cretaceous/Paleocene.

Racemonocolpites hians MULLER 1968.
Description: Monocolpate pollen; single grain, bilaterally symmetrical and isopolar. Colpus almost splitting grain into two halves; exine somewhat pluribaculate. Botanical affinity: *Irirartea* sp.
Age: Late Cretaceous.
*Trichotomosulcites* COUPER, 1953.
*Trichotomosulcites* sp.
Description: Pollen is monocolpate or trichotomocolpate. Colpi have wavy margins and usually rounded ends. Exine pattern is minutely reticulate.
Class Dicolporatae GERMERAAD et al., 1968.
Genus *Multiareolites* GERMERAAD et al., 1968.
*Dicolporites formosus* VAN DER HAMMEN, 1956, p.85, pl.6, fig.16
*Multiareolites formosus* (VAN DER HAMMEN, 1956) ex GERMERAAD et al., 1968, p.301, pl.VI, fig.1,2.
Description: Pollen with double rows of areoli. Single grain, radially symmetrical, isopolar, prolate. Dicolporate, narrow colpi with straight borders and pointed ends.
Botanical Affinity: *Justicia American* and *Dianthera Americana*.
Age: Miocene.
Class Tricolporate INVERSEN et TROELS SMITH, 1950.
*Psilatricolporites operculatus* VAN DER HAMMEN et WYMSTRA, 1964.
Description: Single grain pollen, radially symmetrical, isopolar, oblate, circular in outline. Tricolporate, colpi long ectexinous marginate with distinct opercula.
Botanical Affinity: *Alchornea cordifolia*
Age: Miocene.
Genus: *Zonocostites* GERMERAAD et al., 1968.
*Zonocostites ramonae* GERMERAAD et al., 1968, p.329, pl. XV, figs.6,7.
Description: Tricolporate Pollen. Single grain, radially symmetrical, isopolar, spherical. Colpi ectexinous, medium long, straight with pointed ends, slightly costae.
Botanical Affinity: *Rhizophora* (Rhizophoraceae).
Age: Oligocene/Miocene.
Genus: *Echitricolporites* VAN DER HAMMEN, 1956b
*Echitricolporites spinosus* VAN DER HAMMEN, 1956b, p.92, pl.10, fig.30
Description: Single grain, radially symmetrical, isopolar and spherical in shape. Tricolporate, colpi ectexinous, straight with pointed ends, pores indistinct. Spines are always separated and not connected by a reticulate pattern of muri.
Age: Miocene/Pliocene.
Genus *Brevitricolporites* ANDERSON, 1960.
Description: Tricolporate pollen, single grain, radially symmetrical and isopolar. Ora are prominent, prominent annulus with very short colpi that are hardly observed. Exine pattern is reticulate; pollen shape is spheroidal.
Botanical Affinity: Unknown botanical affinity
Age: Oligocene – Pliocene.
Description: Same as *R. obodoensis* but strikingly different in that its ora are prominently protruding.
Age: Oligocene – Pliocene.

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