Available online at www.pelagiaresearchlibrary.com

Pelagia Research Library

Advances in Applied Science Research, 2015, 6(3):1-11

ISSN: 0976-8610
CODEN (USA): AASRFC

Evidences from Palynomorph assemblages depicting Late Cretaceous age for the straddled areas of Anambra and Mid-Niger Basins

[1]Atabo N. Odoma, [2]Nuhu G. Obaje, [1]Joseph I. Omada, [1]Rufai Ayuba and [3]Jochen Erbacher

[1]Department of Earth Sciences, Kogi State University, Anyigba, Nigeria
[2]Department of Geology, Ibrahim Badamasi Babangida University, Lapai, Niger State, Nigeria
[3]Federal Institute for Geosciences and Natural Resources, (BGR), Hannover, Germany

---

ABSTRACT

Samplings of spores and pollen assemblages were done on shale bodies from Mamu in Anambra Basin and Patti in Mid-Niger Basin. This area is straddled portion of both basins of Anambra and Mid-Niger. The straddled areas of the two basins are stratigraphically correlatable and are lateral equivalents of each other. The mappable lithostratigraphic units are Mamu Formation and Ajali Sandstone in the Anambra Basin as well as the Lokoja and Patti Formations in Mid-Niger Basin. Palynological samples from the Anambra and Mid-Niger Basins of Nigeria result in recovery of Cingulatisporites, Longapertites, Ephredites regularis, Monoporites, Echitriporites, Triporites among others characteristic of Cretaceous age and shallow marine environments.

Keywords: Palynomorph, Createceous age, Anambra Basin, Mid-Niger Basin

---

INTRODUCTION

The Anambra Basin comprises an almost triangular shaped embayment covering an area of about 30,000 sq.km. It stretches from the area just south of the confluence of the rivers Niger and Benue across to areas around Auchi, Okene, Agbor and Asaba, west of the river Niger and Anyigba, Idah, Nsukka, Onitsha and Awka area east of the river (Fig.1). The surface area of the basin is marked by the Udi, Idah and Ajaokuta to the east, north and northwest respectively. The Mid-Niger Basin on the other hand, extends from Kotangora in the north to areas slightly beyond Lokoja to as far as Dekina in the south. It is delimited in the NE and SW by the basement complex and merges with the Anambra and Sokoto Basins to the SE and NW respectively (Fig. 2). The basin is a gently downwarped trough whose origin is closely connected with Santonian orogenic movements in SE Nigeria and the Benue valley. The basin trends perpendicular to the main axis of the Benue Trough and the Niger Delta Basin and is regarded as the NW extension of the Anambra Basin, both of which were major depocentres during the third major transgressive cycles in the Late Cretaceous. In this study, the palynomorphs contents of the surface lithostratigraphic units within the straddled part of both basins of Anambra and Mid-Niger were investigated to establish their corellative tendencies. The palynomorphs analyses were done on shale samples from the Mamu Formation of the Anambra Basin as well as the shale samples of Patti Formation from the Mid-Niger Basin.

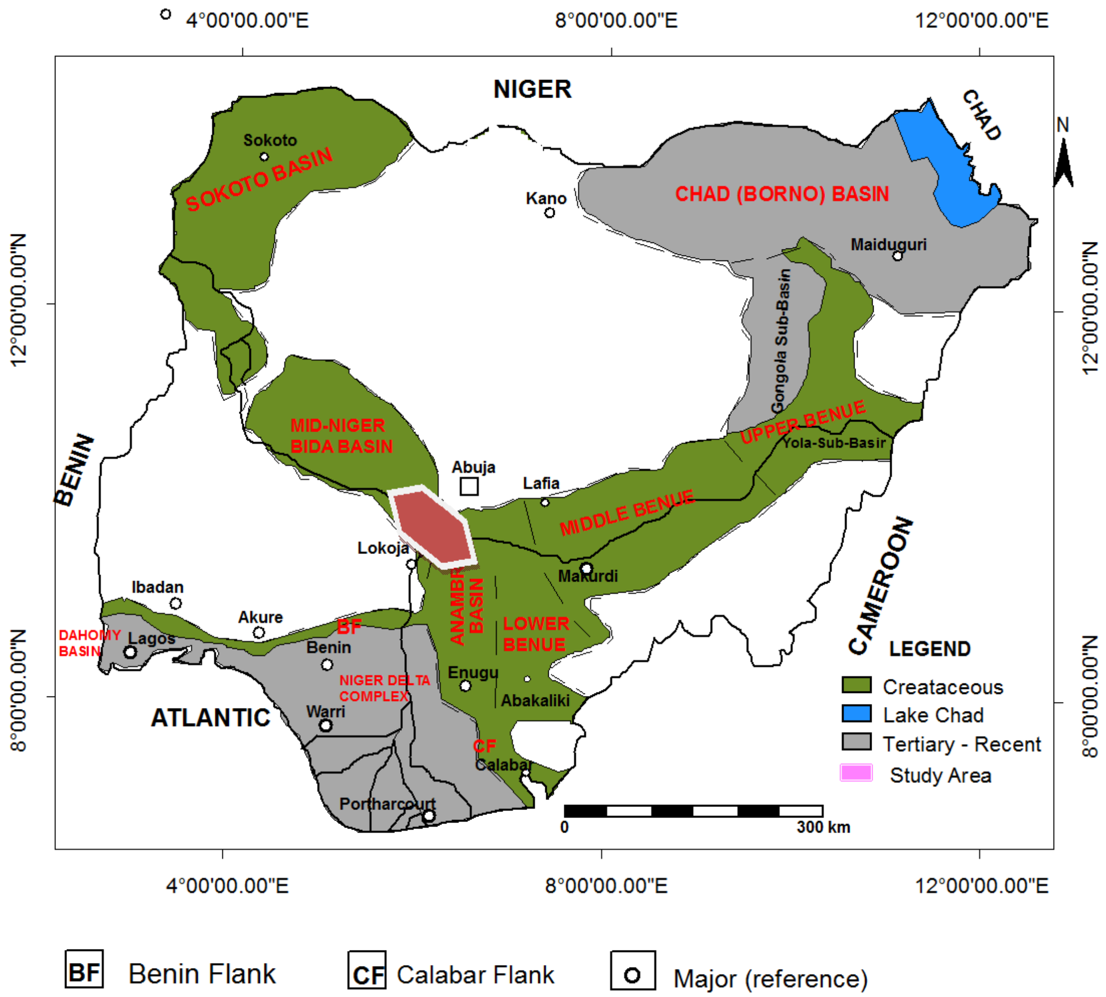

Fig. 1. Geologic map of Nigeria showing the different basins and studied area (modified from [1])

Geologic settings

The stratigraphic setting in the Anambra Basin can be holistically viewed from the point of the Lower Benue Trough. Sedimentation in the Lower Benue Trough commenced with the marine Albian Asu River Group, although some pyroclastics of Aptian-Early Albian ages have been sparingly reported [2]. The Asu River Group in the Lower Trough comprises the shales, limestones and sandstones lenses of the Abakaliki Formation in the Abakaliki area and the Mfamosing Limestone in the Calabar Flank [3]. The marine Cenomanian-Turonian Nkalagu Formation (black shales, limestones and siltstones) and the interfingering regressive sandstones of the Agala and Agbani Formations rest on the Asu River Group. Mid-Santonian deformation in the Benue Trough displaced the major depositional axis westward which led to the formation of the Anambra Basin. Post- deformational sedimentation in the Lower Benue Trough, therefore, constitutes the Anambra Basin. Sedimentation here commenced with the Campanian-Maastrichtian marine and paralic shales of the Enugu and Nkporo Formations, overlain by the coal measures of the Mamu Formation. The fluviodeltaic sandstones of the Ajali and Owelli Formations lie on the Mamu Formation and constitute its lateral equivalents in most places. In the Palaeocene, the marine shales of the Imo and Nsukka Formations were deposited, overlain by the tidal Nanka Sandstone of Eocene age. Downdip, towards the Niger Delta, the Akata Shale and the Agbada Formation constitute the Palaeogene equivalents of the Anambra Basin.

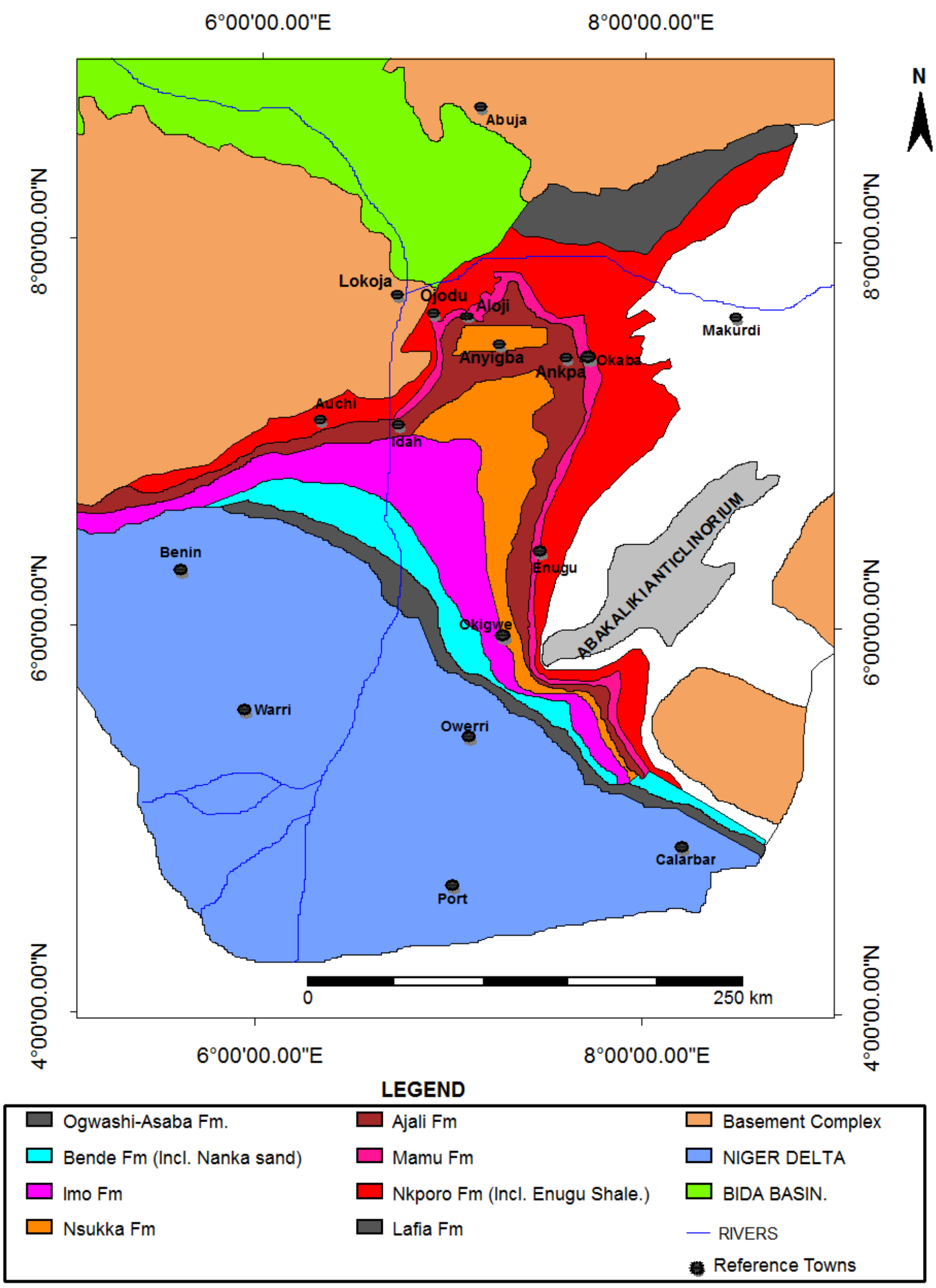

Fig. 2. Geologic map of Anambra Basin (After [4])

The stratigraphic succession of the Mid-Niger Basin, collectively referred to as the Nupe Group [5] comprises a twofold Northern Bida Basin (Sub-Basin) and Southern Bida Basin (Lokoja Sub-Basin). The Bida Basin is assumed to be a northwesterly extension of the Anambra Basin [6]. The basin fill comprises a North West trending belt of Upper Cretaceous sedimentary rocks that were deposited as a result of block faulting, basement fragmentation, subsidence, rifting and drifting consequent to the Cretaceous opening of the South Atlantic Ocean. Major horizontal (sinistral) movements along the northeast-southwest axis of the adjacent Benue Trough appear to have been translated to the north-south and northwesterly trending shear zones to form the Mid-Niger Basin perpendicular to the Benue Trough [7]. The Stratigraphy of Upper Cretaceous succession of the Bida Basin has been documented by [8] in the central parts of the basin around Bida. Four mappable stratigraphic units are recognized in this area, namely, the Bida Sandstone (divided into the Doko and the Jika Member), the Sakpe Ironstone, the Enagi Siltstone and the Batati Formation.these are correlatable with the stratigraphic units in the Southern Bida Basin. In the southern Bida Basin, exposures of sandstones and conglomerates of the Lokoja Formation directly overly the Pre-Cambrian to Lower Palaeozoic basement gneiss and schists. This is overlain by the alternating shales, siltstones, claystones and sandstone of the Patti Formation thick in the Koton-karfi and Abaji axis and succeeded by the claystones, concretionary siltstones and ironstones of the Agbaja Formation.

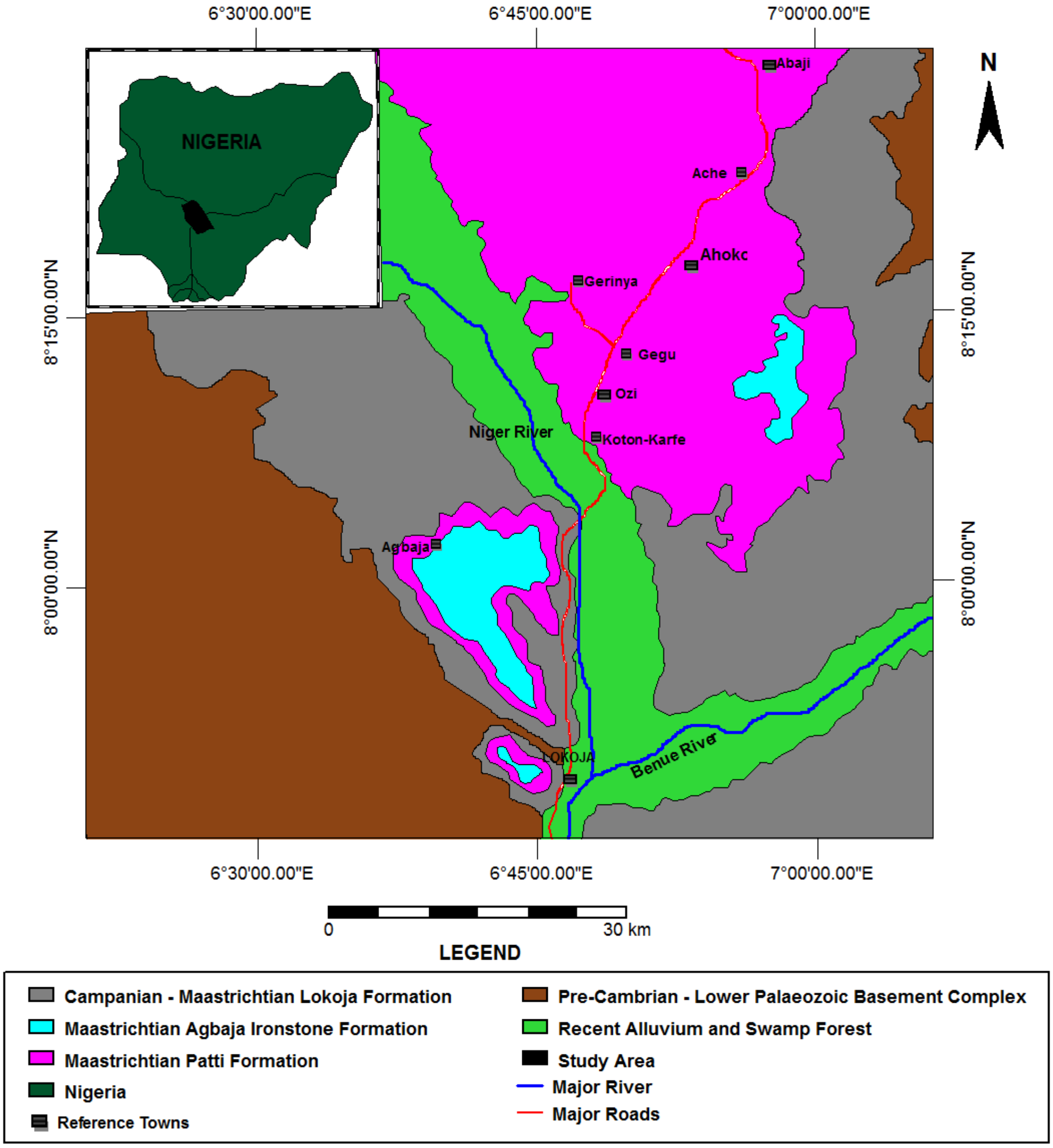

Fig. 3. Geologic map of the Mid-Niger Basin (modified from [6])

MATERIALS AND METHODS

Twenty (20) samples of shale from northern Anambra Basin and Mid-Niger Basin were processed for palynological study. Five grams of each crushed samples were treated with 10% HCl to remove the carbonates, which was followed by neutralization with distilled water. Then hydrochloric acid was added in order to dissolve the silicates, which was again followed by neutralization with distilled water. The acid-insoluble residue was ultrasonically sieved (mesh size: 10µm). The organic residue was mounted on slides with glycerin jelly. Photo documentation of probably stratigraphical interesting palynomorphs was made (microscope: Leitz DM RB; microscope camera and software: Leica EC3 with Leica Application Suite) at the Federal Institute for Geosciences and Natural Resources (BGR), Hannover, Germany.

RESULTS AND DISCUSSION

The palynomorph species recovered from these units are of potential Biostratigraphic utility according o published informations on the Palynology of West, North Africa and northern South America.

Systematic Palynology

The stratigraphic and geographic distributions of some selected and reported species found in these basins (Anambra and Mid-Niger) in relation to other basins elsewhere are given below:

Genus: *Cingulatisporites* [9]
Cingulatisporites ornatus [10]

Stratigraphic and geographic distribution
Maastrichtian Coal Measures, Nigeria [10]
Maastrichtian S.W. Nigeria [11]
Mastrichtian Gombe Sandstone N.E. Nigeria [12]
Mamu Formation (Ojodu), Anambra Basin, Nigeria (This Study)

Genus: *Longapertites marginatus*

Description: Grains with a long aperture over two third of the greatest circumference of the grain. Perforate tectum, with columellae arranged in a certain, sometimes reticular-like pattern.

Stratigraphic and geographic distribution:
Maastrichtian Coal Measures, Nigeria [10]
Mamu Formation (Ojodu), Anambra Basin, Nigeria (This study)

Genus: *Ephredites regularis*

Description: Polyplicate pollen grain. Psilate. Between the ridges furrow-like openings occur.
Maastrichtian, Lower Coal Measures
Mamu Formation (Ojodu), Anambra Basin, Nigeria (This study)
Patti Formation (Abaji), Mid-Niger Basin, Nigeria (This study)

Genus: *Longapertites* [10]
Longapertites microfoveolatus [11]

Stratigraphic and geographic distribution
Palaeocene Kerikeri Formation [12]
Maastrichtian S.W. Nigeria [11]
Campanian to Maastrichtian Gombe Sandstone [12]
Mamu Formation (Ojodu), Anambra Basin, Nigeria (This study)

Genus: *Longapertites marginatus* [10]

Description: Monocolporate pollen with a long aperture and reticulate.

Dimensions: Length 65µm, width 50µm, exine thickness up to 2µm

Stratigraphic and geographic distribution
Maastrichtian S.E. Nigeria [10]

Maastrichtian to Mid-Eocene S.W. Nigeria [14]
Palaeocene Kerikeri Formation Nigeria [13]
Campanian to Maastrichtian Gombe Sandstone [12]
Mamau Formation (Ojodu), Anambra Basin, Nigeria (This study)

Sub Class: *Monoporites* [15]

Genus: *Milfordia* [16]
Milfordia sp.

Description: Large pollen grain, circular, monoporate and with large circular pore. The exine is thick and tectate. The ornamentation is foveolate.
Stratigraphic and geographic distribution: Upper Cretaceous Pindiga Formation [12].
Mamu Formation (Ojodu), Anambra Basin, Nigeria (This study)

Genus: *Echitriporites* [14]
Echitriporites trianguliformis [14]

Description: Triporate pollen isopolar, radially symmetrical, triangular and convex in polar view and coarsely echinate

Stratigraphic and geographic distribution: Maastrichtian upper coal measure, Nigeria [10]
Maastrichtian Senegal and Ivory Coast [17]
Maastrichtian to Eocene, tropical regions [18]
Senonian to Palaeocene, Malaysia [19]
Palaeocene to Lower Eocene, Brazil [20]
Campanian to Lower Maaastrichtian, Surinam [21]
Campanian to Maastrichtian, Gabon [22]
Maastrichtian Bituminous Sands W. Nigeria [1]
Upper Cretaceous Pindiga Formation [12]
Mamu Formation (Ojodu), Anambra Basin, Nigeria (This study)
Patti Formation (Abaji), Mid-Niger Basin, Nigeria (This study)

Genus: *Stephanocolporate (zone)* [23]
Stephanocolporate (zonorate) sp.

Description: Colporate pollen, radially symmetrical, isopolar, circular in polar view with 19 equitorially arranged colporate aperture and regulate.

Stratigraphic distribution
Mamu Formation (Ojodu) Anambra Basin, Nigeria (This study)

Genus: *Triporites* [24]
Triporites sp.

Description:Triporate pollen, large, radially symmetrical, triangular convex and scabrate.

Stratigraphic distribution
Mamu Formation (Ojodu), Anambra Basin, Nigeria (This study)

Explanations to Fig. 4

1-15 = Campanian- Maastrichtian dinoflagellates
1-5. = Cleistopshaeridium cf. huguoniotii (Valensi) [25]
6, 7 = Spiniferites supparus (DRUGG) [26]
8-10 = Florentinia sp.
11 = Deflandreacean dinoflagellate [27]
12 = Micrhystridium sp.
13-15 = Apteodinium cf. thelium [26]
16 = Echitriporites trianguliformis
17 = Aricipites sp. [17]
18 = Stephanocolporate zonorate
19 = Scytinaceae (foraminiferal linings)
20 = Echitriporites trianguliformis
21 = Arecipites sp. [17]
22 = Cicatricosisporites cf. Orbiculatus
23-24 = Polypodiaceoisporites retirugatus
25 = Liliacidites sp
26-27 = Rotverrusporites granularis
28 = Cleistopshaeridium cf. huguoniotii

Explanations to Fig. 5

1 = Florentinia laciniata seghiris
2, 3 = Cingulatispories ornatus, nov, fsp
4 = Cicatricosisporites cf orbiculatus
5 = Lycopodiacidites asperatus
6 = Mycrhystridium sp.
7 = Longapertites discordis
8 = Lepdolepidites major
9 = Retitriporrites sp.
10 = Triporites sp.
11 = Cleistopshaeridium cf.
12 = Echitriporites trianguliformis
13 = Stephanocolporate zonorate
14 = Cleistopshaeridium cf. huguoniotii (Valensi) [25]
15 = Leptolepidites major
16 = Leptolepidites
17 = Triporites sp.
18 = Lycopodiacidites asperatus
19 = Retitricolporites cf. pristinus
20 = Milforda sp.
21 = Ephredipites sp.

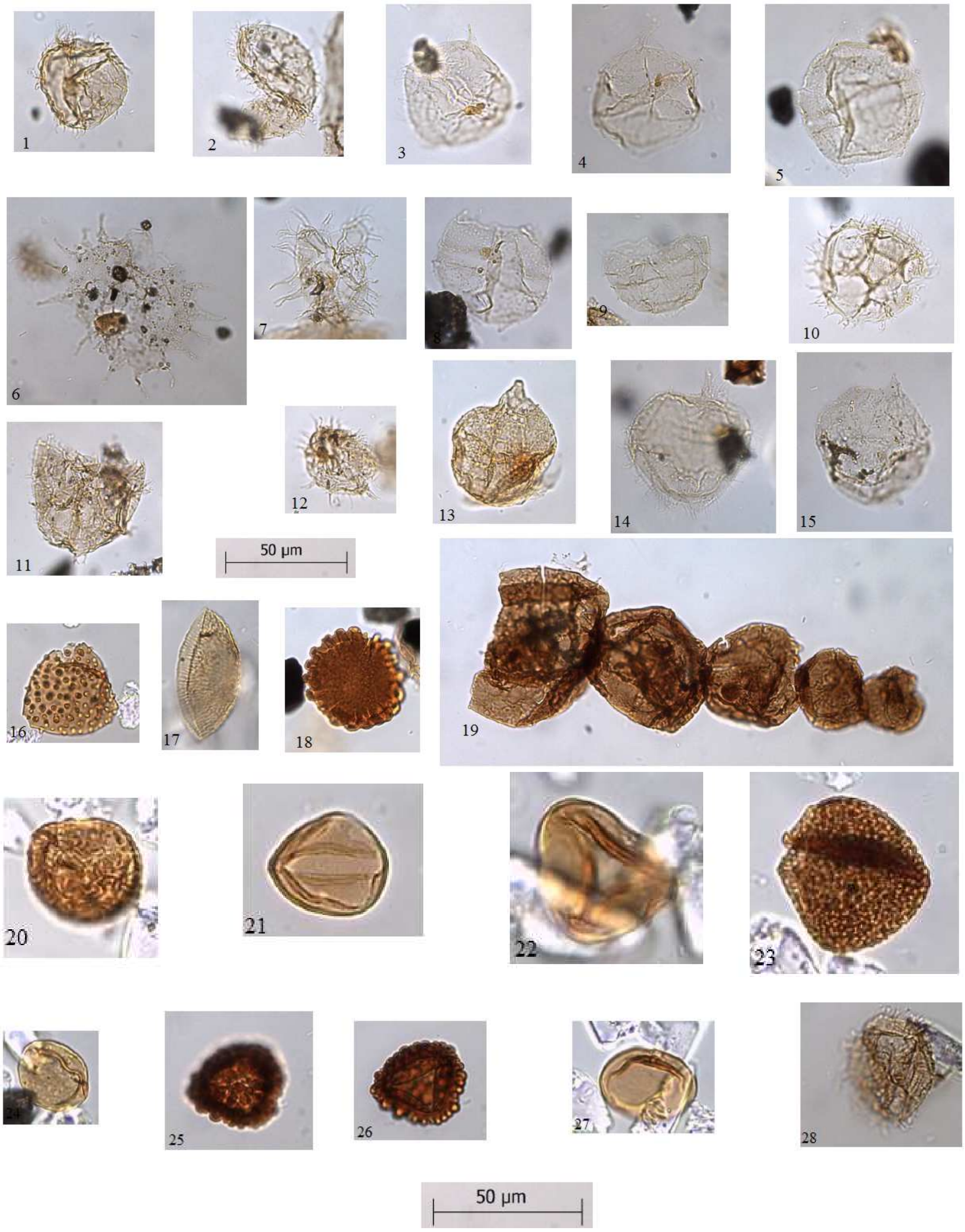

Fig. 4. photmicrographs (SEMs) of palynomorphs recovered from the Ahoko Shale

Fig. 5. Photomicrographs (SEMs) of palynomorphs recovered from Ojodu Shale

Table 1. Pollens, Spores and Dinoflagellates assemblages as recovered from Ojodu (Northern Anambra Basin)

	Palynomorphs		II.I	II.II	II.III	II.IV	II.V
	Cicatricosisporites cf. Orbiculatus		◊	+	◊	*	*
	Cingulatisporites Ornatus		*	+	◊	◊	*
	Leptolepidites Major		*	+	+	+	+
	Lycopodiacidites asperatus		*	+	+	+	+
	Retitriporites sp.		*	+	◊	◊	+
	Retitricolporites cf. pristinus		*	+	+	+	*
	Rotverrusporites granularis		*	◊	◊	*	+
	Echitriporites trianguliformis		◊	+	+	*	*
	Ephredites sp.		*	*	+	+	◊
	Ephredites regularis		*	◊	+	+	◊
	Longarpetites sp.		+	◊	◊	+	*
	Longarpetites marginatus		+	◊	◊	+	*
	Longarpetites microfoveolatus		◊	*	*	+	*
	Milfordia sp.		*	◊	+	◊	*
	Retistephanocolpites angeli		+	◊	*	◊	+
	Stephanocolporate zonorate		*	+	*	◊	◊
	Triporites sp.		◊	+	+	*	*

Explanation: **+** *Abundant* ◊ *Common* * *Rare*

Table 1. Pollens, Spores and Dinoflagellates assemblages as recovered from Ahoko (Mid-Niger Basin)

	Palynomorphs	Slide Nos.	I.I	I.II	I.III	I.IV
	Arecipites sp.		+	+	*	*
	Cicatricosisporites cf. orbiculatus		◊	+	+	*
	Polypodiaceoisporites retirugatus		◊	+	+	+
	Rotverrusporites granularis		+	+	+	*
	Echitriporites trianguliformis		+	+	+	+
	Liliacidites		*	+	+	*
	Stephanocolporate zonorate		+	+	*	+

Explanation: **+** *Abundant* ◊ *Common* *** *Rare*

CONCLUSION

The high Ephredripites contents of the Mamu Formation at Ojodu (Northern Anambra Basin) suggests dry hinterland conditions which is also supported by clay mineralogical data (e.g. Abu Ballas Formation of Egypt in [28] attempts at explanation should take into consideration the large-scale importance of some of these events. The Aptian dry phase in Egypt is paralleled by a Barremian- Aptian dry phase in Western Europe [29], and the overall trend from dry conditions in the Aptian to humid conditions in the Maastrichtian-Campanian occurs not only in Egypt but similarly in West Africa. The opening of the Atlantic, the establishment of a zonal circulation system and the Campanian-Maastrichtian transgressions could have contributed to the observed changes. Sea level changes and mountain building processes have also been involved, but some astronomical parameters, e.g. the Milankovich periods which have influenced hyperarid and fluvial periods in the Pleistocene sahara, are effective on a time scale beyond the resolution of non-marine Cretaceous biostratigraphy.

Triporate pollen grains, which are generally accepted as being indicative of Late Cenomanian or younger ages [17], [30], have been reported in Ojodu and Ahoko (see plates). These triporate occurrences may be derived from Late Cenomanian to Earliest Turonian of Nigeria ([31] as *Guetaceaepollenites sp.1*).

The presence of Retricolporites (reported from Late Turonian- Santonian, [32]) and Triporites sp. (an Early Senomanian-Early Maastrichtian species of Jardine and Magloire, raises the possibility that these samples are even younger than Late Cenomanian.

The association of rare marine palynofossils (dinoflagellates and/or foraminiferal linings) with few freshwater algae as observed in both basins and abundant spores and pollen suggests deposition in a marginal marine environment with strong influx of fresh water and land derived material.

Absence of marine palynofossils in some samples may be related to fluctuations of marine influence in a paralic environment.

Acknowledgement
This paper is based on part of Ph.D thesis under the supervisions of N.G Obaje of IBB University, Lapai, Nigeria, J.I. Omada of KSU Anyigba, Nigeria and J. Erbacher of BGR, Hannover, Germany. The first author is grateful to the senate of Kogi State University for providing TETFUND sponsorship that enables him to undertake analysis of the samples at the laboratory of Federal Institute of Geosciences and Natural Resources (BGR) Hannover, Germany.

REFERENCES

[1] N.G. Obaje., M.K. Musa., A.N.Odoma and H.Hamza. *Journal of Petroleum and Gas Exploration Research*. Vol. 1(1), **2011**, pp.001-013.
[2] Ojo, K.A. *NAPE Bull* 7; **1992**, 131-152.
[3] Petters, S.W. *Palaeontographica Bd. Abt*. A. **1982**, 179: 1-104.
[4] Obaje, N.G. Geology and Mineral Resources of Nigeria. Spriger Books, Heidelberg, **2009**, 221pp.
[5] Adeleye, D.R. *Journal of sedimentary petrology* **1973**, 43, 709-727.
[6] Akande, S.O., Ojo, O.J., Erdtmann, B.D., Hetenyi, M. *Journal of Earth Sciences* **2005**, 41, 394-406.
[7] Benkhelil, J. *Journal of African Earth Sciences* **1989**, 8, 251-282.
[8] Adeleye, D.R., Dessauvagie, T.J.F. Stratigraphy of the Mid-Niger Embayment near Bida, Nigeria. In: Dessauvagie TJF, Whiteman, AJ (eds) Proceedings of the Conference on African Geology. Ibadan University Press, Ibadan, **1972**, pp 181-186.
[9] Thomson, P.W., Pflug, H.D. Pollen und Sporen des mitteleuropiaischen Tertiars. Palaeontographica **1953**, 94b pp.1-138.
[10] Van Hoeken- Klinkenberg, P.J.M. *Pollen et Spores*, **1964**, 6: 209-231.
[11] Jan Du Chene, R. *Rev. Esp. Micropal*., **1977**, 9, 2:191-201.
[12] Lawal, O. Biostratigraphie, palynologique et paleo-environmentes des formationscretacees de la Haute-Benoue, Nigeria nord-oriental. These de Doctorat de Specialite, Universite de Nice, France. **1982**, 198 pp.
[13] Adegoke, O.S., Jan Du Chene, R.E., Agumanu, A.E., Ajayi, P.O. *Esp. Micropal*., **1978**, 10, 2: 267-283.
[14] Van Hoeken-Klinkenberg, P.J.M. Maastrichtian, *Leidse Geol. Meded*. . **1966**; 38, pp 37-48.
[15] Potonie, H. *Beih. Geol.Jahrb*. **1960**; 39 pp 1-189. [16]
Erdtmann, G. Pollen morphology and plant taxonomy (An introduction to palynology1). Angiosperms, Almqvist and wiskell, stockhom, Chronica Botanica Co., Walthan, Mass. **1960**, 239pp
[17] Jardine, S., Magloire, L. Palynologie et stratigraphie du Cretace des basins du Senegal et de Cote divoire. Memoires du Bureau de Recherches Geologiques et Minieres. **1965**, 32, 187-245.
[18] Germeraad, J.H., Hopping, C.A., Muller, *Rev. Palaeobot. Palynol. 69 (3,4)*, **1968**, pp.189-348.
[19] Muller, J. *Micropaleontology* 14(1), **1968**, Pp.231-235.
[20] Regali, M.S.P., Uesugui, N., Santos, A.S. *II-Bol. Tecn. Petrobas* 17(4), **1974b**, pp.263-301.
[21] Belsky, C.Y., Jardine, S., Prestat, B., Durif, P., Grosdidier, E., Cassan, J., Gilmann, M. Etude stratigraphique et sedimentologique dune coupe du cretace-Tertiare au large du Surinam. IX Inter Guyana *Geol. Bol. Geol.* Venezuela, **1975**, 179-197.
[22] Boltenhagen, E. La *Rev. de* Micropal. **1976b**, 18**,** no. 4, 191-199.
[23] Kuyl, O.S., Muller, J., Waterbolk, H.T. *Geol. Minjbouw*. **1955**, 17, pp. 49-76.
[24] Van der Hammen, T H. *Bol. Geol. (Bogota*) 4(2, 3), **1956**, pp.111-117.
[25] Davey, R.J., Williams, G.L. The genus Hystrichosphaeridium and its allies. In: Davey, R.J., Downie, C., Sarjeant, W.A.S., and Williams, G.L., **1966** Studies on Mesozoic and Cainozoic dinoflagellates cysts. *Bull. Mus. (Nat. Hist) Geol. Supplement*, **1966a**, **3**, pp. 53-106
[26] Sarjeant, W.A.S. The genus Spiniferites Mantell, 1850 (Dinophyceae): Grana, **1970**, 10, pp.72-78
[27] Schrank, E. *Geologische Rundschau*, **1994**, 83, 773-786.
[28] Hendriks, F., Schrank, E. *J. Afr. Earth Sci.*, **1991**, 10:471-481.
[29] Ruffell, A.H. & D.J. Batten. *Palaeoecol*, **1990**, 80:197-212.
[30] Schrank, E. *Cretaceous Research*, **1992**; 13, 351-368.
[31] Lawal, O., Moullade, M. *Reveu de Micropaleotologie*, **1986**, 29, 61 83.
[32] Ibrahim, M.I.A. and Abdul-Kareem, M.R. Late *Cretaceous Res*., **1991**, 18, 633-660.