CARD International Journal of Science and Advanced Innovative Research (IJSAIR)
ISSN: 2536-7315 (Print) 2536-7323 (Online)
Volume 2, Number 1, March 2017
http://www.casirmediapublishing.com

Miospores and Geological Boundaries in Maastrichtian to Lutetian Succession of Ajire -1 Well, Anambra Basin, Nigeria

Lucas, F. A.

Department of Geology,
University of Benin, Benin-City, Nigeria
E-mail: drfalucas@gmail.com

ABSTRACT

Evaluation and appraisal of biostratigraphically significant miospores in Ajire-1 well, Anambra Basin allow the delineation of five geological stage boundaries from Maastrichtian to the Lutetian succession of the well. The delineated boundaries are Maastrichtian/Danian, Danian/Selandian, Selandian/Thanetian, Thanetian/ Ypresian and Ypresian/Lutetian respectively. Estimate of the numerical ages have been possible by the comparison of the miospore events with those of dinocysts recognized in the well. Five Eocene diagnostic miospores- *Mauriitidites crassiexinus, Grimsdalea pol ygonallis, Forma 'C', Psilatriclpites okeziei* and *Proteacidites otamirinensis,* originally described from the upper Eocene Ogwashi –Asaba Formation, south-east Nigeria have their first stratigraphic occurrences in the Early Eocene. This is the first attempt in which miospores are being used in Nigeria to delineate the Paleocene epoch into three internationally recognized stages. It is envisaged that the information documented in this study would further refine the Nigeria Chronostratigraphy and bring it in-line with new standard global stratigraphy scale.

Keywords: Miospore; Geological Boundaries; Maastrichtian; Lutetian; Ajire-1 Well; Anambra Basin; Nigeria.

INTRODUCTION

Ajire-1 well is situated in the western part of Anambra Basin at Latitude 6° 15'N and Longitude 6° 45'E (Figure-1). Drilled in 1972 by Shell Petroleum Development Company of Nigeria (SPDC), it has a total penetrated depth of 2500m. The well penetrated the thickest and most complete sub-surface Maastrichtian to Lutetian Succession in Southern Nigeria. Four sub-surfaces Lithostratigraphic Formation – Ajali Sandstone, Nsukka Coal Measure, Imo Shale and Ameki Sand were penetrated in the well. The Anambra basin is located between the Benue trough in the North and Niger delta in the south (Fig.1). The Anambra Basin is a Cretaceous/Tertiary basin, which is the structural link between the Cretaceous Benue Trough and the Tertiary Niger Delta basin (Lucas and Ishiekwene, 2010). This sedimentary phase was initiated by the Santonian folding and uplift of the Abakaliki anticlinorium along the NE-SW axis, and the consequent dislocation of the depocenter into the Anambra Basin on the Northwest and the Afikpo syncline on the Southeast (Short and Stauble, 1967; Murat, 1972). The resulting succession comprises the Nkporo group, Mamu formation, Ajali sandstone, Nsukka formation, Imo formation and Ameki group. Hydrocarbon exploration in the Anambra Basin has been dependent on the abundant Maastrichtian coal deposits.

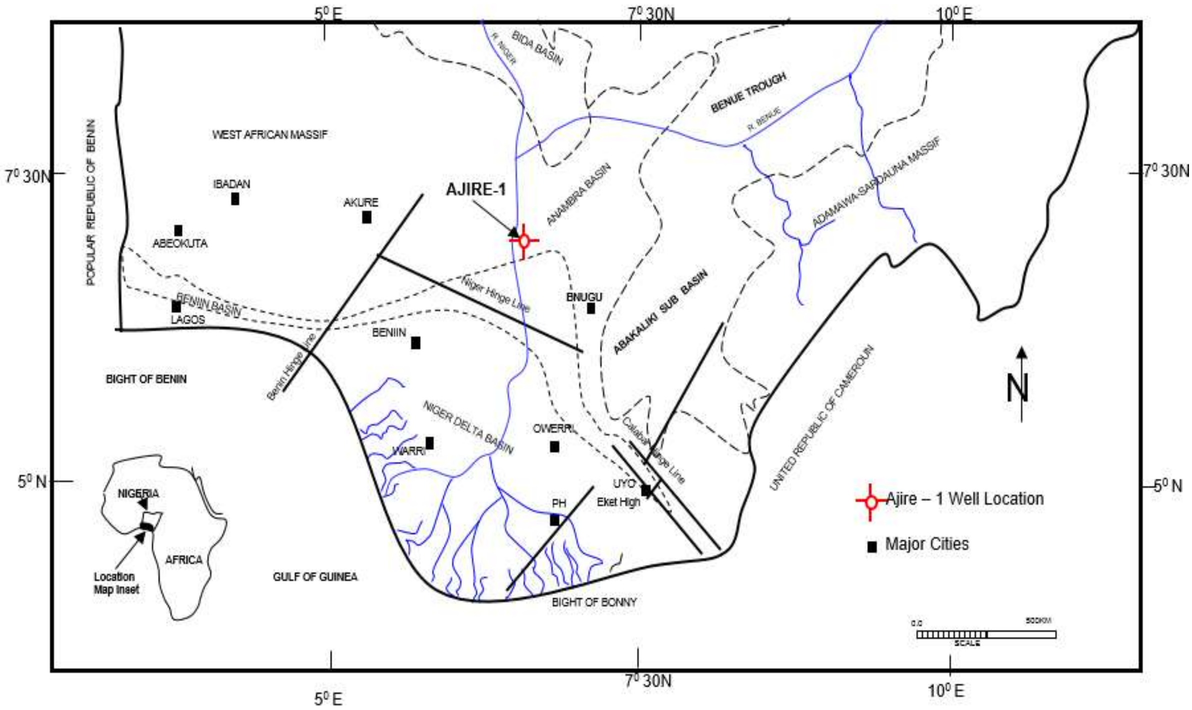

Fig. 1: Map of Southern Nigeria Sedimentary Basins showing Ajire-1 Well Location

MATERIALS AND METHODS

Fifty-one (51) side wall samples were collected and subjected to standard palynological maceration involving different treatments of HCl, Hf, HCl, Schultz's solution, KOH chemical digestions. The organic matter was recovered using zinc Bromide solution of 2.2

specific gravity. The organic residue was subsequently mounted on a glass slide with Canada balsam for microscopic analysis.

Out of the identified palynomorphs (dinocysts, acritarchs, pollen and spores) the pollen and spores were evaluated and appraised for their biostratigraphic utility to delineate geological stage boundaries in the well section. The comparison of the pollen and spores events with those of dinocysts and acritarchs, allowed the estimation of the numerical ages of the stage boundaries and some pollen and spores events where ever possible (Fig.3). All the numerical ages cited in this paper are of global foram zones. The reference slides were curated in the micropaleontological laboratory, centre for palynological studies, at University of Sheffield, England. All coordinates given in this paper are reverse England finder coordinates.

RESULTS AND DISCUSSION

Age and stage boundaries

K/T (Maastrichtian-Danian) Boundary

The K/T boundary is at 1835m based on the quantitative occurrence of *Ericacea* pollen and first stratigraphic occurrence of *Proxapertites cursus* (van der Hammen, 1956) at the interval which suggests Paleocene age. This pollen type according to Van der Hammen (1956) occurs for the first time just about the Maastrichtian – Danian (Paleocene) boundary in South America. This event which is being reproduced in the Ajire-1 well, also agrees with the study of Germeraad *et al* (1968) where the pollen was found to occur for the first time just above the Maastrichtian – Danian (Paleocene) boundary in Nigeria. Furthermore, the oldest occurrence of *Mauritidites crassibaculatus* (Van Hoeken-Klinberg; 1964) is at 1921m just below the Maastrichian – Danian boundary. This is similar to the observation of Van der Hammen (1956) in the Maastrichain – Danian boundary of South America. The co-occurrence of *P. cursus* and the dinocyst *Damassadinium californicum* FAD at 1835m suggests a numerical age of 65.0 Ma. *D. californicum* FAD is a global marker for K/T boundary.

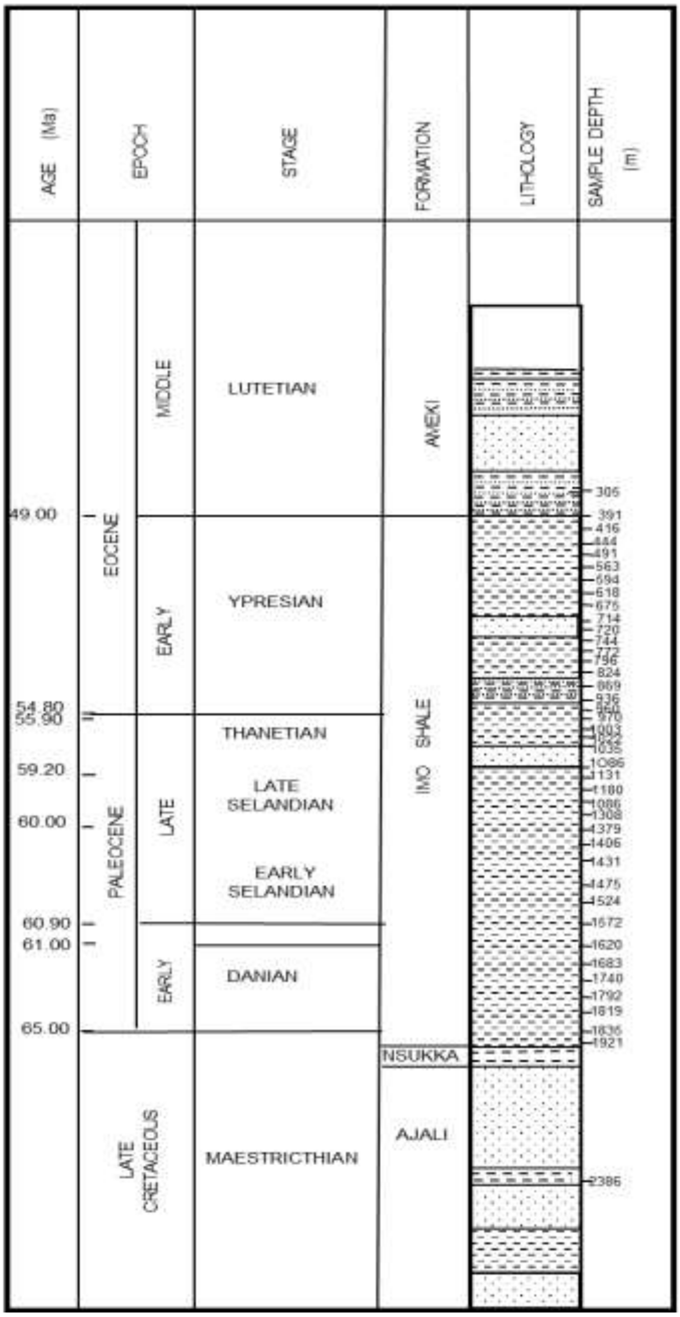

Fig. 2: Lithostratigraphic section and Age of Ajire-1 well

AJIRE - 1 (BY FIRST APPEARANCE)

DEPTH (METERS)	AGE	STAGE	LEIOTRILETES TRIANGULUS	MAURITIIDITES CRASSIBACULATUS	ERICACEA sp. (TETRAD)	SYNCOLPORITES MARGINATUS	LONGAPERTITES PROXAPERTITOIDES var> PROXAPERTITOIDES	CINGULATISPORITES CLAVUS	ECHIMONOCOLPITES MINUTUS	PSILATRIPORITES ROTUNDUS	CYATHIDITES AUSTRALIS	ECHITRIPORITES TRIANGULIFORMIS	PROXAPERTITES CURSUS	LONGAPERTITES VANEENDENBURGII	LONGAPERTITES MARGINATUS	RETISTEPHANOCOLPITES WILLIAMSII	SPINIZONOCOLPITES BACULATUS	CYATHIDITES MINOR	PROXAPERTITES OPERCULATUS	PROXAPERTITES TERTIARIA	TETRACOLPORITIES sp> 111(DRUGG)	ELAEIS GUINEENSIS	LONGAPERTITES PROXAPERTITES var. RETICULATUS	MONOPORITES ANNULATUS	RETITRICOLPORITES IRREGULARIS	LAEVIGATOSPORITES OVATUS	CYCADOPITES GIGANTEUS	RETIDIPORITES MAGDALENENSIS	ANACOLOSIDITES cf. LUTEOIDES	VERRUCATOSPORITES USMENSIS	SUBTRIPOROPOLLENITES SUBPORATUS	BOMBAX CEIBA	PRAEDAPOLLIS AFRICANUS	FOVEOTRICOLPORITES EMENTITUS	MONOCOLPITES MARGINATUS	MAURITIIDITES CRASSIEXINOUS	CATOSTEMMA COMMUNE	INTRATRIPOROPOLLENITES A(ROUSE)
305	ME	LUTETIAN											36			1			17						5									31	4			
391													11						3				2	6		1				1								
416	EARLY EOCENE	YPRESIAN									4		6											2											4			
444									3		7	2	3			2		1	10					4	7	1				5							2	
491									1		11	5	4			4		1	10					1	14					13					3	3		
563										1	6								20						5					4	1			1				3
594									7		23	2	9			5			65					3	13	1				13	3		1		19			
618									1	2	7					2			11					3	10										18	6		
675									3	1	9		11			6			24				4		53	7				11			4		25	21		
714											14		6			6			22				1	7	64	5				8			1	1	16	5		
720											8	2	4			11		2	32					6	42	1				9			1		17	4		
744										1	4	3	15			6			14					12	54	7				16					15	7	1	
772									7	2	2		29			7			25					16	26	1	1			15				1	13	4	2	
796							3		9		4		2	2		13			13				3	2	16	2	1			10			4		15	20	3	
824									4	1	1		2			2			7				1	2	27					7					6	40	1	
896										3			5			9			17				3		55	4				7			2		5	32	3	
936							3		6										7						4	3	2				2		1			3		
960											2														4	2												
970	LATE PALEOCENE	THANETIAN					25																7				2											
1003							4								2											1									2			
1022													1										2				5	4								1		
1035			10				2	1	3				7										3			1		1		2								
1086			7		1		1				10	2	8		3	2	1		8									2		3		1					1	2
1131		LATE SELANDIAN	20	4	8			1			3		8	5		3			3		1		3				3									3	3	3
1180			11	3			4		5		3		5	3					1				4				10									2		
1229			8						4		5	1	3	2		2			2																	4	1	
1308							4						2								3		4	1			1								1			
1379		EARLY SELANDIAN	10	3	3			2	6		5		16	8	6			2	1				1	8		1	3								2	3		
1406			17	2	2		3	3	4		5		11	12				4	3				5	4		6	3			1								
1431				1			4	1	2		1		2	2									4				2						1	1				
1475			17	4	9				1		4		10	1		2		4	2		1		2	12		1	4			2		1						
1524			16	6	4				5					1					5	2	2		3	20	2	2	5		3	1	2							
1572			2				4	4												16							2											
1620	DANIAN	DANIAN	10	2	12		2		3		4		6	3	5	2		4	5	5				10		8	4	2										
1683			7	10	4		4		3		3	2	5	15	6				3	6						1												
1740			8	7	9		6		8	2	3		4	14	1			4	8		3		4	1	3													
1792			12	3	10		20	2	3		4		10	23	20	5		4	10	5	2	3																
1819			10		2									23	6		2																					
1835			6	7	20	4				3	9	12	3	20	4	2																						
1921	LC	MAESTRICHTIAN	15	17	1	2	4	1	8																													
2386			20																																			

DEPTH (METERS)	BACULATRIPORITES ORLUENSIS	BOMBACACEA ELLIPTICUS	CRASSORETITRILETES VANRAADSHOOVENII	SPERMATITES sp.	NIGERIPOLLIS GEMMATUS	PERFORTRICOLPITES DIGITATUS	ZONOCOSTITES RAMONAE	RETIBREVITRICOLPORITES PROTRUDENS	DOUALADITES LAEVIGATUS	CTENOLOPHONIDITES COSTATUS	CTENOLOPHONIDITES LISMAE	PSILATRICOLPITES OKEZIEI	SCRABRATRIPORITIES SIMPLIFORMIS	FORMA "C" (JAN DU CHENE et al)	CRANWELLIPOLLIS GOMBEENSIS	STRIATRICOLPITES CATATUMBUS	CROTONOSCULPUS CROTONOISCULPIUS	RETIBREVITRICOLPORITES OBODOENSIS	LORANTHACIDITES NATALIAE	TRIORITES TENUIEXINOUS	SYNCOLPORITES CORRUGATUS	RETITRICOLPORITES CLARENSIS	RETIBREVITRICOLPORITES TRIANGULATUS	POLYVESTBULOPOLLENITES sp. (SALAMI)	PLICAPOLLIS PSEUDOEXCELSUS	MONOCOLPITES BACULATUS	PSILATRICOLPITES sp.I (ADEGOKE et al)	ANACOLOSIDITES sp.	PROTEACIDITES OTAMIRINENSIS	SYNCOLPORITES PORICOSTATUS	BREVICOLPORITES GUINETEII	MARGOCOLPORITES VANWIJHEI	SPIROSYNCOLPITES BRUNII	RETITRICOLPITES ELLIPTICUS	BORRERIA VERTICILLATA	GRIMSDALEA POLYGONALLIS.
305						7	7			3						9	2																		2	3
391							1											1										4						3		
416							12									2																				
444							14	1								2	6		1	12			2							1			2	8		
491							9							2		5	1		3	62		2	3			1		2			2		2	3		
563																																				
594					3								2			3	2				2	4	2				2		3	2	3	1				
618												1				2			1	1	4							2	3	3						
675												1				4						2		1			1	2	1							
714					1							1		1	3	4	2			3			1	1			2									
720					3						3	2		1	2	3				5	2	5	1		3	2	1									
744	1											4	2			1				3		4	3	2	1											
772												2	2	3	6	1			3	2	3															
796												2		3	5		3	2																		
824							6							2	2																					
896			1										2	3	8	2	1																			
936												1	1																							
960																																				
970																																				
1003											1																									
1022	1								1	1																										
1035			2		1	11	2	1																												
1086	3	1	3	2																																
1131	3																																			
1180																																				
1229																																				
1308																																				
1379																																				
1406																																				
1431																																				
1475																																				
1524																																				
1572																																				
1620																																				
1683																																				
1740																																				
1792																																				
1819																																				
1835																																				
1921																																				
2386																																				

Fig. 3: Quantitative stratigraphic distribution of pollen and spores in Ajire – 1
* LC: LATE CRETACEOUS
ME: MIDDLE EOCENE

Danian

The Danian is defined as the interval from FADs *P. cursus* and *Echitriporites trianguliformis* at 1835m (K/T boundary) to the FAD *Retidiporites magdalenensis* at 1620m, other bio-events in the Danian are FADs *P.operculatum* and *Monoporites annulatus.*

Danian/Selandian boundary

This could be delineated by the *FAD Retidiporites magdalenensis* at 1620m which marks the top of the Danian. The first down-hole influx of *Proxapertites tertiaria* defines the base of Selandian at 1572m. The base is also characterized with scarcity and low diversity of miospores (Fig.3). Comparison of the miospore event at the boundary with the FAD of *Apectodinium homomorphum* at 1620m suggests 61.0Ma for top Danian and 60.90Ma for base Selandian.

Selandian

The Selandian is defined as the interval from the first down-hole influx of *P. tertiaria* at 1572m to the extinctions of *Bombax ceiba* and *Ericacea* pollen at 1086m. *Bombax ceiba* is restricted to the Selandian in Ajire-1 well. The FAD of *Anacolosidites luteoides* at 1524m is diagnostic of earliest Selandian which occurs just above the base of Selandian. Van Hoeken –Klinkenberg (1964) recorded *Mauritiidites crassibaculatus* extinction in three selected Nigerian wells: Owan-1, Egoli-1 and Gbekebo-1 in the late Paleocene. The extinction of this pollen is at 1131m in the late Selandian just below the Selandian/Thanetian boundary.

Selandian/Thanetian boundary

This is at 1086m based on the concurrent extinctions of *Bombax ceiba* and *Ericacea* pollen type and FADs of *Crassoretitriletes vanraadshoovenii* and *Spermatites Sp* at 1086m.

Thanetian

The Thanetian is defined from the extinction of *Bomba ceiba* and *Ericacea* pollen type at 1086m to the FADs of *Psilatricolpites okeziei* and *Scrabratriporites simpliformis* at 936m which delineates the base of Ypresian. The top of Thanetian is just below this interval at 960m. The Thanetian as a whole in this well is characterized by scarcity and /or low diversity of miospores (Fig. 3). Van der Hammen and Mutis (1965) noted the extinction of *R. Magdalenensis* in the Paleocene of Colombia, Germeraad *et al* (1968) also noted the same event in the late Paleocene of Nigeria. The extinction of *R. Magdalenensis* is at 1022m in Thanetian of Ajire-1 well section.

Thanetian/Ypresian boundary

This boundary is characterized by scarcity and /or low diversity of miospores. The boundary is at 936m, based on the FADs *Psilatricopites okeziei* and *Scrabratriporites simpliformis* respectively.

Ypresian

The Ypresian is delineated from FADs *P. Okeziei* and *S. simpliformis* to the extinction of *Anacolosidites Sp.* at 391m which defines the Ypresian – Lutetian boundary. The Ypresian is characterized by typical Eocene miospores recovered by Jan du chene *et al* (1978) from Upper Eocene Ogwashi – Asaba Formation South – East Nigeria. These miospores include *P. Okeziei, Proteacidites otamirinensis, Psilatriporites rotundus* and *Forma 'C'.* Other Eocene age diagnostic miospores restricted to ypresian in this well are *S. corrugatus, Anacolosidites Sp.* and *Retribrevitricolpites trianguliformis.*

Ypresian/Lutetian boundary

The extinction of *Anacolosidites* Sp. at 391m delineates the Ypresian/Lutetian boundary. This event has been used over the years by Shell Petroleum Development Company of Nigeria for the recognition of the Ypresian – Lutetian boundary in Nigeria. This event co-occurs with the FAD *Baltisphaeridium nanum.* There is an influx of *B. nanum* an acritarch species at the boundary. The numerical age is 49.0Ma.

Lutetian

The Lutetian is represented by two samples recovered from 391m and 305m intervals. One Eocene diagnostic pollen, *Grimsdalea polygonallis* reported by Jan du chene *et al* (1978) from the upper Eocene of Nigeria has its FAD in the Lutetian of Ajire-1 well section.

CONCLUSION

Miospores recovered from Ajire-1 well permitted the delineation of geological stage boundaries from Maastrichtian to Lutetian succession. These are Maastrichtian/ Danian/ Selandian/ Thanetian/ Ypresian/ Lutetian respectively. Comparison of the events at each boundary with assemblages and miospore records in other parts of the world, and those of the dinocyst and acritarch observed in this well allows estimate of their numerical ages. Five Eocene diagnostic miospores- *Mauriitidites crassiexinus, Grimsdalea polygonallis, Forma 'C', Psilatricolpites okeziei* and *Proteacidites otamirinensis* which were originally described from upper Eocene Ogwashi-Asaba Formation by Jan du chene et al (1978) have their first stratigraphic occurrences in Early Eocene of the well. The information documented in this paper would contribute to the interpretation of sub-surface sequence stratigraphy of Southern Nigeria sedimentary basin.

ACKNOWLEDGEMENTS

I am grateful to the Nigerian National Petroleum Corporation for the opportunity of an in-service training during the critical stage of this study at Sheffield. The paper is a part of Ph.D. degree research work carried out under the supervision of Dr. Roger Neves, the then Director, Industrial Palynology Unit, University of Sheffield, Sheffield, England. Funding received from British Council and EEC is gratefully acknowledged. I am also grateful to Dr. Roger Neves for the supervision of my Ph.D. degree work.

REFERENCES

Germeraad, J. H., Hopping, C. A. and Muller, J., 1968. Palynology of Tertiary Sediments from tropical areas. Review of palaeobotany and palynology, vol. 6, pp. 189 -348, p1-1-18.

Hammen, T. Van der and Mutis, C. G. D., 1965. The Palaeocene flora of Colombia. leidse Geol. Mededel, vol. 35, pp. 105-116.

Hammen, T. Van der., 1956. A palynological systemmatic nomenclature. Colombia Inst. Geol. Nac. Bol. Geol., vol. 4(2-3), pp. 63-101, p1. 1-12.

Jan du Chene, R. E, Onyike, M. S. and Sowunmi, M. A., 1978. Some new Eocene pollen of the Ogwashi-Asaba Formation, South eastern Nigeria. Rev. Esp. micropal., vol. 10(2), pp. 285-322, p1.1-2.

Lucas, F. A. and Ishiekwene, E., 2010. Miospore (Pollen and Spore) Biozonation Model for Late Cretaceous – Tertiary Succession of Gbekebo-I Well, Benin Flank, Anambra Basin, Nigeria. *World Journal of Applied Science and Technology*, vol. 2(2), pp. 303-308.

Murat, R. C., 1972. Stratigraphy and Paleogeography of the Cretaceous and Lower Tertiary in Southern Nigeria. In: Dessauvagie, T. F. J., Whiteman, A. J. (Eds.), African Geology. *University of Ibadan Press*, Nigeria, pp. 251-266.

Short, K. C. and Stauble, A. J., 1967. Outline of Geology of Niger Delta. *Bull. Amer. Assoc. Pet. Geol.*, vol. 51(5), pp. 761-779.

Van Hoeken – Klinkenberg, P. M. J., 1964. A palynological investigation of some upper Cretaceous sediments in Nigeria. Pollen et spores, vol. 6(1), pp. 209-231, p1.1-7

PLATE 1

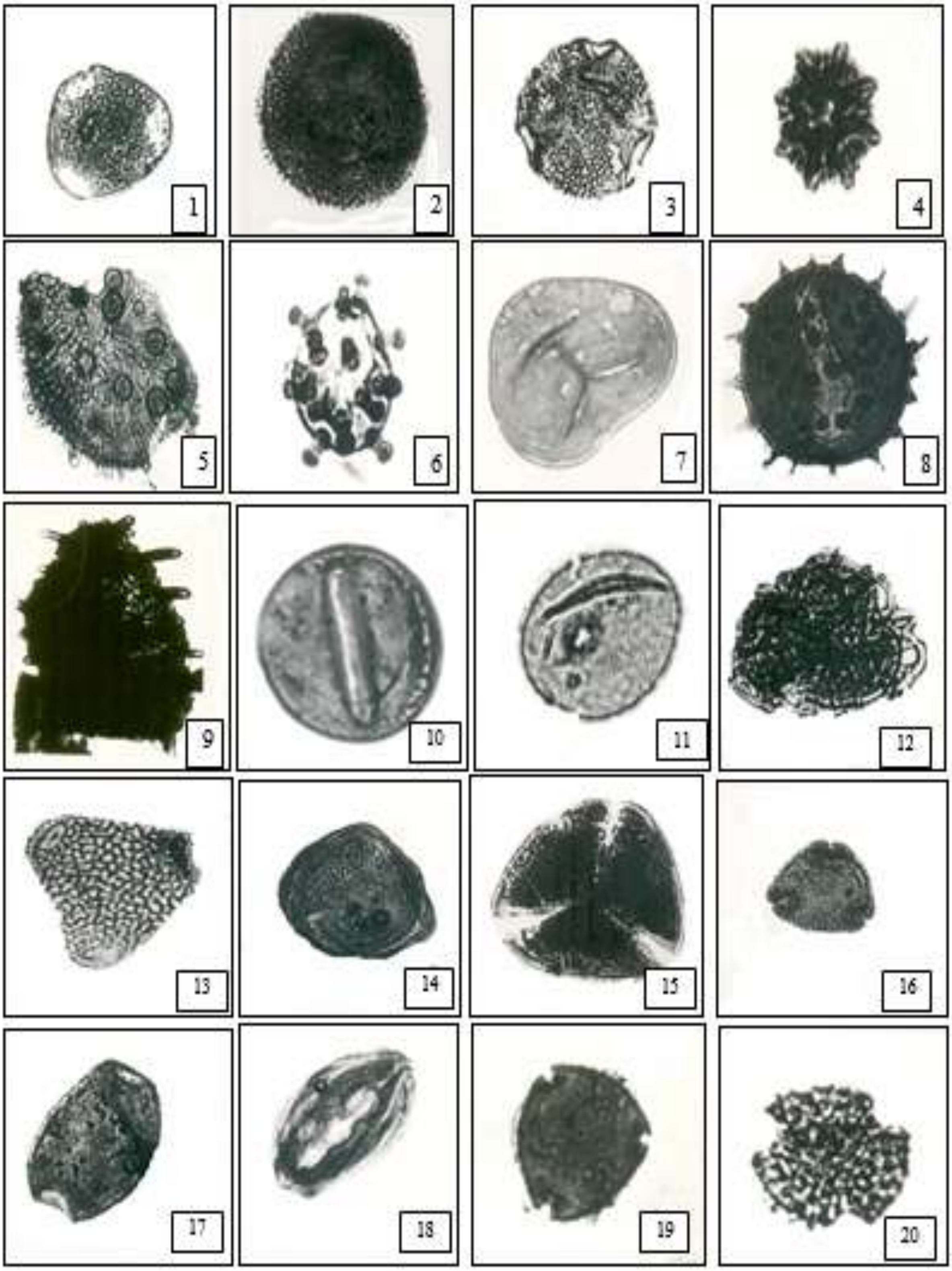

PLATE 1

Miospores photographs indicating the slide number, England Finder's coordinates and magnification of individual specimen.

1. *Anacolosidites sp.* AJ2248B Q19/1 X750
2. *Bacutriporites orluensis* AJ2059B1 L26/2 X750
3. *Cramwellipollis gombensis* AJ2654B1 E16/2 X750
4. *Ctenolophonidites costatus* AJ1015B2 U32/1 X600
5. *Forma'C'* Jan du chene, AJ2895B2 014/3(4) X750
6. *Grimsdalea polygonallis* AJ1015B2 Q32/4 X500
7. *Leiotriletes triangulus* AJ4918B2 034/3 X600
8. *Mauriitidites crassiexinus* AJ2745B2 T32 X750
9. *Monocolpites baculatus* AJ2400B1 G36/3 X500
10. *Monocolpites marginatus* AJ2248B1 E22 X600
11. *Monoporites annulatus* AJ2895B1 E39/4 X750
12. *Praedapollis africanus* AJ2574B1 F36 X750
13. *Proteacidites otamirinensis* AJ1981B2, X19/2 X500
14. *Proxapertites cursus* AJ2378B2 U15 X500
15. *Psilatricolpites okeziei* AJ2654B1 P21/1 X750
16. *Retibrevitricolporites triangulates* AJ1918B2, Q35/2 X500
17. *Retidiporites magdalenensis* AJ3405B4 Q34 X500
18. *Striatricolpites catatumbus* AJ2378B1 T18/1(3) X750
19. *Syncolporites corrugatus* AJ2895B2 D36/3 X900
20. *Verrutricolporites irregularis* AJ2895B2 R25 X750