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PALYNOLOGY AND PALAEO ENVIRONMENT OF THE PATTI FORMATION, SOUTHERN BIDA BASIN, NIGERIA

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ABSTRACT

Palynological analysis of fifty samples of Ahoko/Ahoko Gbayi sediments in Bida Basin, North Western Nigeria, confirms a Middle to Late Maastrichtian age for the shale interval of Patti Formation. This dating is based mainly on certain well preserved marker angiosperm species such as *Monocolpollenites sp, Monocolpites marginatus, syncolporites substilis* and *Echitriporites trainguliformis* among others. The overwhelming terrestrially derived palynofloras dominated by Palmae and Protecean angiosperms (96.4%) are indicative of the predominance of fluviatile environment during the deposition of the dark shale units probably in a restrictive body of water.

KEY WORDS: Formation, Palynomorphs, Palaeoecology, Palaeoenvironment, Biostratigraphy.

INTRODUCTION

The age of Bida Basin has largely been determined by palaeontological evidence (Adeleye and Dessauvagie, 1972; De klazz, 1978; Adeleye, 1979, 1989) while the palynostratigraphic record of its rock units is fragmentary (Jan du Chene *et al*, 1978; Mebradu *et al.*, 1986). The terrestrial to marginal marine origin (Adeyeye, 1989; Braide 1992; Ladipo *et al.*, 1994) of its sediments prevent independent dating and the general siliciclastic nature of the basin's rocks (predominantly sandstones) which is not suitable for palynomorphs recovery hinders a complete palynological record (Traverse, 1988, Mahmoud, 2003). Salami (1985) even reported that the basin's materials were not found suitable palynologically. However, the Patti Formation which contains well exposed carbonaceous shales (among other rock units) at the center of the basin provides a good section for the recovery of palynomorphs.

In the present study angiospermous pollen from the shale unit are abundant, diverse and well preserved. They represent flowering plants that were evolving rapidly and were widely distributed during the deposition of sediments. These characteristics offer direct and strong biostratigraphic evidence for determining the age and palaeoenvironment of the Patti Formation which is significant for the proper understanding of the geology of the basin. Again the highly diverse nature of the angiospermous assemblage will enrich the basin's palaeofloristic data and provide a means of correlation with other basins within and outside Nigeria.

Geologic setting of the Basin

Bida Basin is a NW – SE trending depression that is perpendicular to the main axis of the Benue Trough (Fig. 1 and 2). It lies between longitude 4^0E and 7^0E and latitutde 7^0N and 10^0N and covers an area of 3,500km^2 with about 3km thick Upper Cretaceous sedimentary fill in its deepest part (Russ, 1957; Adeleye, 1974; Ojo, 1984; Adeniyi, 1984, 1986). Several authors considered the basin to be a rift bounded tensional structure. This is said to be produced by faulting associated with the Benue Trough and the drifting apart of the African and South American plates consequent to the break-up of these plates in the Late Jurassic to Cretaceous times (Kogbe, 1981; Whiteman, 1982; Ojo and Ajakaiye, 1989). The evolution and development of the basin was attributed to wrench movements associated with the tectonic framework of the Nigerian sedimentary basins (Braide, 1990). Over the years, the basin has been subjected to various geological investigations centred on its stratigraphy and sedimentology (Jones, 1955, 1958; Adeleye, 1972, 1973, 1974, 1976; Adeleye and Dessauvagie, 1972; Braide, 1992, Ladipo *et al.*, 1994), hydrogeology (Shekwolo, 1983), biostratigraphy (De Klazz, 1978; Adeleye, 1979) and hydrocarbon potential (Braide, 1990; Akande and Ojo, 2002).

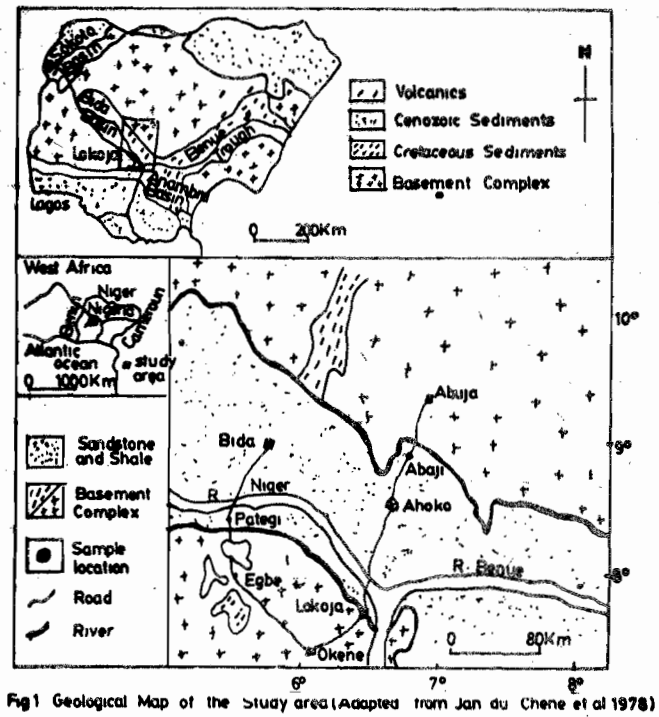

Fig 1 Geological Map of the Study area (Adapted from Jan du Chene et al 1978)

Four mappable lithostratigraphic units and their lateral equivalents, based on lithologic and depositional characteristics, are recognizable in the two major study sections (Bida and Lokoja) of the basin. These are the Bida/Lokoja Sandstones, Sakpe Ironstones/Patti Formation, Enagi Siltstones/Patti Formation and Batati/Agbaja Ironstones in ascending order. These lateral equivalents (Fig.2), both within the basins and in the adjoining Anambra Basin represent the continuous depositional phases, from the south to the north and northwest, controlled by the major sea level rise and fall during the Upper Cretaceous time (Berquist, 1971; Douglas *et al.*, 1973).

The abundant oolitic ironstone deposits in the basin equally

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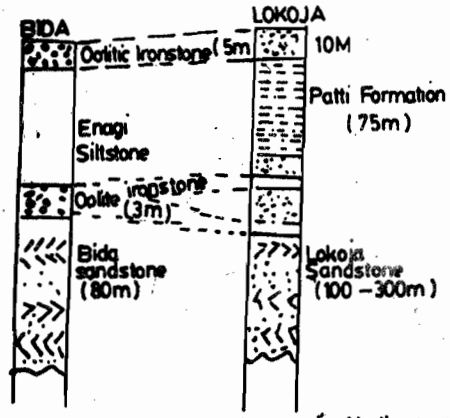


Fig 2a - Correlation of sediments in Northern and Southern Bida sub-basins (modified from Adeleye & Dessauvagie 1972)

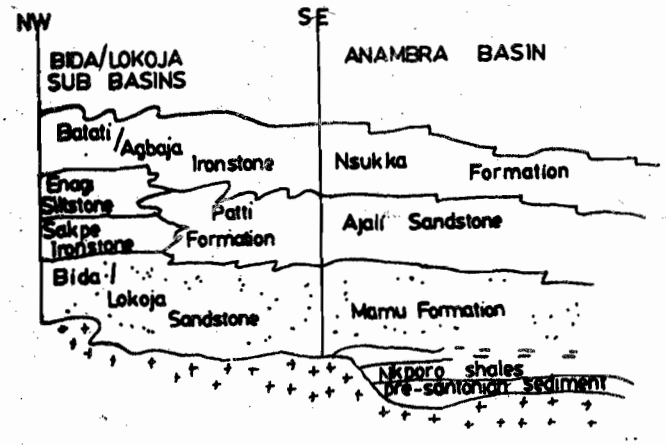


Fig 2b Correlation of Bida Basin to Anambra Basin (After Akande et al 2003)

attracted the attention of several researchers (Adeleye, 1973, 1989; Ladipo *et al.*, 1994, Abimbola, 1997).

The depositional environment was said to have been dominated by a continental fluvial sedimentation while the presence of intercalated concretional/oolitic ironstones and some arenaceous foraminifera have been ascribed to occasional marine incursion during the rise in sea level (Ojo and Akande, 2003).

MATERIAL AND METHODS

Stratigraphic sections of Patti Formation located between Ahoko/Ahoko Gbayi along Lokoja – Abaji Road in the central part of the basin were studied. Field data were collected on lithologic characteristics, stratigraphic features and details of sedimentation. Fifty samples were processed using standard palynological procedures. Slides were prepared from unsieved residue using glycerine jelly as mounting medium.

Due to the clastic nature of the sediments, the majority of the processed samples were barren of palynomorphs. Seven samples contain palynomorphs suitable for the present work. For each sample between 150 and 200 grains were counted and recorded in semi-quantitative term (Table1)

Palynological Assemblage

Quanlitative data: The noticeable picture presented by the well preserved palynomorphs (plates 1 & 2) recovered in this study is the dominance of angiospermous pollen. The angiosperms are made up of several species of *Echitriporites*, *Monocolpollenites*, *Inaperturotetradites*, *Psilatricolpites* and *Psiladicolpites*. Other important monocolpates such as *Arecipites*, *Longapertites* and *Retidiporites* occur sporadically. The fungal spores and fungal fruiting bodies occur in almost all the samples as minor constituents except in sample 7 where Aseptate fungal spores are noticeably abundant. The

Table 1: Semi-quantitative distribution of Palynomorphs recovered in the Patti Formation Shale.

Sample No	1	2	3	4	5	6	7
Angiosperm pollen							
Perisyncolporites gigenteus Kiesser Jan du Chene 1979	•	•	·	·	·		
Syncolporites subatilis Jandu Chene 1979	•	·	·	•	·	·	•
Monocolpollenites sp.	•	·	·	·	·	·	
Monocolpites marginatus van Hoeken Klinkenberg 1964	•	•	•	•	•	·	
Constructipollenites ineffectus Klinkenberg 1964	•	·	•	·	·		·
Psilamonocolpites major	•	•	·	·	·		•
Echimonocolpites major Jan du Chene 1979	•	·	·	•	·	·	·
Longapertites vaneendenburgi Germarsad *et al.* 1968.			·	·	•	·	·
Psilatricolpites sp.	•	•	•	•	•	•	•
Psiladicolpites sp.	•	•	•	•	·	•	
Retidiporites sp.	·			·		·	
Psilatriporites sp.	•	•	·	•	•	·	·
Echitriporites trianguliformis van Hoeken Klinkenberg 1964	•	•	•	•	•	·	•
Retistephanocolpollenites williamsi Germarsad *et al.* 1968	•	•	•	•	•	•	•
Inaperturotetradites reticulatus Salard Cheboldaeff 1981	•	•	•	·	•	·	·
Arecipites microreticulatus Anderson 1960		·	·	·	•		
Erecipites pachyexinous Salami 1985	·			·			
Fungal spores							
Aseptate fungal spore	·	·		·			•
Diporicellaesporites sp.	·	·		·			
Dyadosporites sp.	·		·				
other fungal spores					·		
Acritarch							
Mirchystridium breve Jasomius	·	·	·				
Baltisphaeridium sp. sensu Sarjeant 1974	·	·					

· <10 specimens (rare); • 10 -20 specimens (common); • > 20 specimens (abundant).

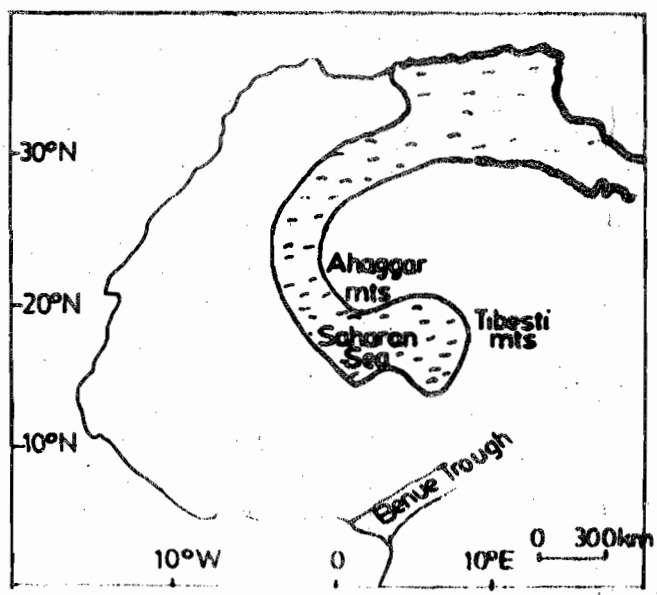
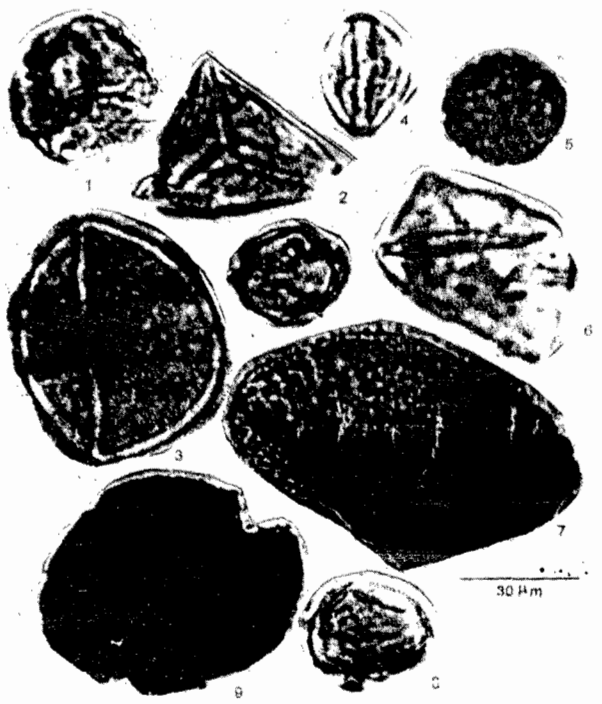
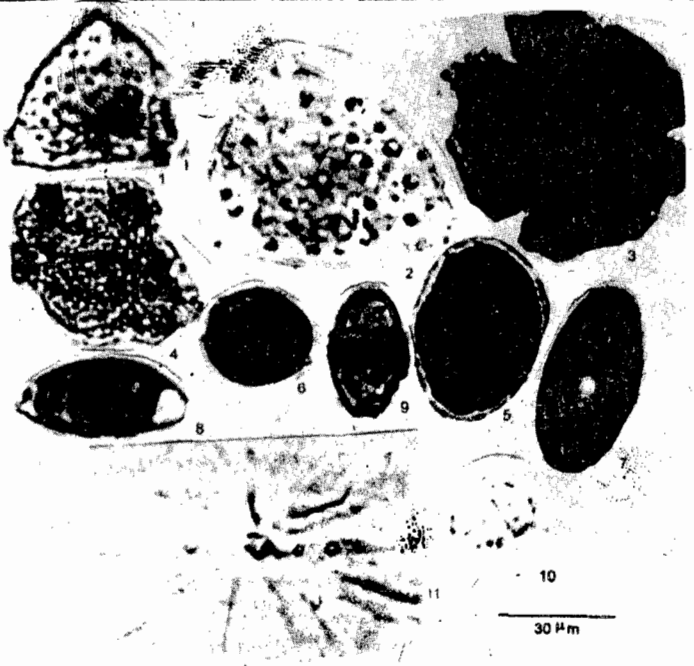


Fig 3. Campanian - Maastrichtian Paleogeography of North and Central West Africa (modified from Kogbe, 1976 and Petters, 1978)



1. *Perisyncolporites giganteus*
2. *Syncolporites substilis*
3. *Monocolpollenites sp.*
4. *Morocolpites marginatum*
5. *Constructipollenites nieffectus*
6. *Psilamonocolpites major*
7. *Echimonocolpites major*
8. *Psilatricolpites sp.*
9. *Psiladiolpites sp*
10. *Psilatripocites sp.*



1. *Echitriporites trianguliformis*
2. *Echitriporites*
3. *Retistephanocolpollenites williamsi*
4. *Inaperturotetradites reticulatus*
5. *Arecipites microreticulation*
6. *Erecipites pachyexinius*
7. *Aseptate* fungal spore
8. *Diporicellasporites sp.*
9. *Dyacloporites sp.*
10. *Mirchystridium brevo*
11. *Baltisphaeridium sp.*

Plate 1 & 2

occurrence of minor constituents of microplankton is represented by two species of acritarch, *Mirchystridium* and *Baltisphaeridium*, in samples 1 – 3.

Quantitative data: Generally, the trend of the occurrence of the palynoflorule in the studied samples is similar (Table 1, fig. 3). The percentages of angiosperm pollen vary from 76% to 98%, fungal spores and fungal fruiting from 1% to 12% and acritarch from 1% to 3%. Monocolpates (eg. *Monocolpites marginatus* and *Echimonocolpites major)* and triporates (e.g. *Echitriporites trainguliformis)* are the most abundant, reaching up to 29.6% and 19% respectively (fig. 4). *Longapertites vaneendenburgi, Retidiporites sp.* and *Arecipites pachyexinous* are rare, although they are significant from a stratigraphic point of view. Tricolporates, stephanocolpates and tricolpate psilate forms, which are regular and often high in distribution, constitute other important taxa. For example, *Syncolporites substilis* varies from 2.7% in sample 2 to 12% in sample 7 while the percentage of *Retistephanocolpollenites williamsi* varies from 5% in sample 2 to 11.5% in sample 6.

Biostratigraphy

Palynological age: Only the relative abundance of stratigraphically significant angiospermous species was used in assigning age to the shale unit of the Patti Formation. This is due to the paucity of age diagnostic organic – walled microplanktons probably because of the terrestrial nature of the formation.

The recovered palynomorph assemblage is closely comparable to those of the Maastrichtian interval of coeval tropical-subtropical Africa, South – America and India (Van Hoeken – Klinkenberg, 1964; Jardine and Magloire, 196; Herngreen ... 2, 1975 a&b; Jain, 1975; Jan du Chene *et al.*, 1978 a&b; Salard Cheboldaeff, 1981; Baksi and Deb, 1981; Shrank, 1987; Edet and Nyong, 1994; Shrank and Mahmoud, 1998, 2000; Mahmoud, 2003). The present palynoflora association encompasses several Palmae Palynomorphs that are found in rocks of Maastrichtian age (Herngreen *et al.*, 1996; Mahmoud 2003). This is clearly evident from the occurrence of Palmae (*Monocolpollenites)* as well as syncolporates *(Syncolporites)* and triporates *(Echitriporites trainguliformis,* Protecean) angiosperms. Contemporary angiospermous palynomorphs of Campanian – Early Maastrichtian ages such as *Foveotricolopites giganteus/gigantoreticulatus, Propopylis (Proteacidites) dehaani* and spores *(Zlivisporis blanensis* and *Verrucosisporites sp.)*(Jardine and Magloire, 1965; Mahmoud, 2003) are absent in the present assemblage. The shale unit of the Patti Formation may therefore post – date these moispores. The Upper Maastrichtian assemblage described from southern and northeastern Nigeria (Van Hoeken – Klinkenberg, 1964; Jan du Chene, 1977 Lawal and Moullade, 1986; Salami, 1988, Edet and Nyong 1994) contains essentially the same angiospermous elements as recovered in the present study. Again, the assemblage is comparable to the sequence II of Jardine and Magloire (1965), the transatlantic *Proteacidites dehaani Zone* of Germeraad *et al.* (1968), Assemblage zone C and D of Adebayo and Ojo (2004) as well as Assemblage zone IV of Lawal and Moullade dated Upper Maastrichtian. Therefore, in addition to the *Granulatisporites subgranulosus* recorded by Mebradu *et al.* (1986), the presence of well preserved *Echitriporites trainguliformis, Monocolpites marginatus, Syncolporites subtilis, Periretisyncolpites giganteus* and *Constructipollenites ineffectus* further support and confirm a Middle to Late Maastrichtian age for the Patti Formation shale.

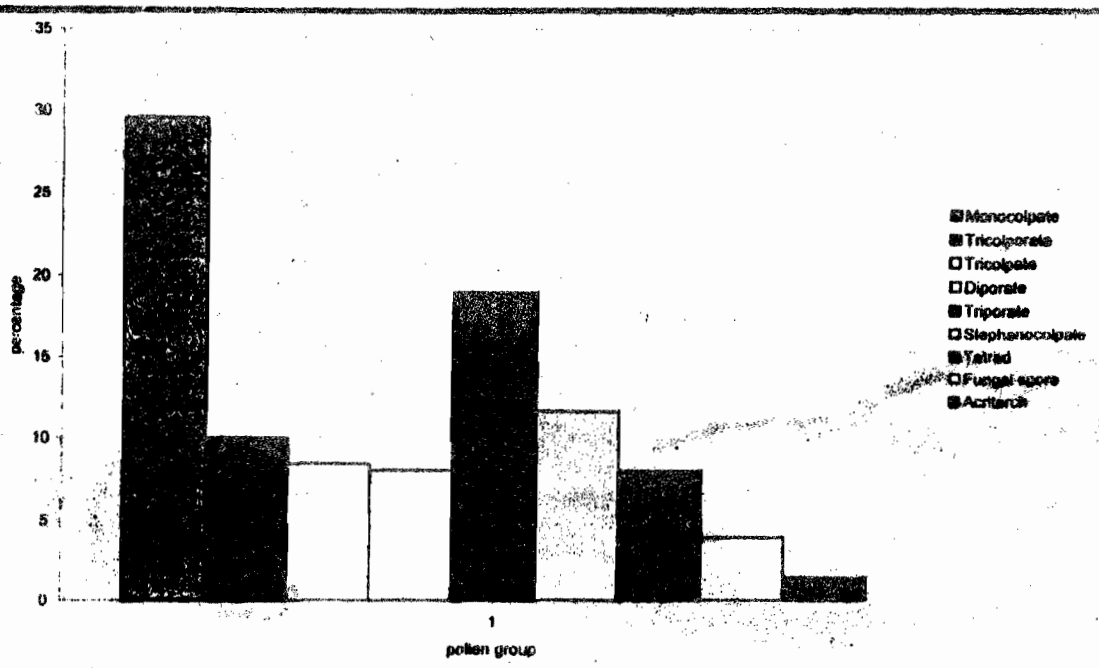


Fig. 4: ***Percentage distribution of pollen groups in the study area***

Palaeoecological Interpretation

Palaeocological deductions were based on the field data, the bulk composition of the recovered palynomorphs and their botanical affinities. The dark-light grey, fissile and carbonaceous shale and well laminated siltstones which are interbedded rhythmically by conceretional or massive and bioturbated ironstones indicated deposition by suspension setting in a quiet, low energy environment probably in a restricted body of water (Harms *et al.* 1975; Braide, 1992; Adebayo and Ojo, 2004). However, occasional marginal marine or brackish condition seemed to have existed as shown by the presence of bivalve moulds, few acritarch specimens *(Mirchystridium* and *Baltisphaeridium),* pyritised *Ammobaculites* and *Milliamina* species (in some samples processed separately for foraminifera) and concretional ironstones (Hubert, 1963; Staplin, 1961; Sarjeant, 1974 Norris, 1978). The brakish water must have been brought to the basin through the trans-Saharan seaway (Furon, 1963; Barr, 1972). The northerly connection of the basin with the Tethys Sea was probably via the Sokoto area of the Illumeden Basin during the Campanian-Maastrichtian marine transgression (Kogbe, 1976 and Adeleye, 1979) (Fig.3). The absolute dominance of the palynomorph assemblage by Palmae *(Monocolpollenites)* and Protecean *(Echitriporites)* angiosperms (Table 1) is indicative of terrestrially derived palynoflora. This view is supported by the abundant woody and plant materials that are land-derived. Thus the prevailing environment during the deposition of Patti Formation shale is fluviatile. The total absence of Nypa-like mangrove pollen *(Spinizonocolpites)* and the marine dinocysts equally support a continental setting with relatively dry conditions in the basin during the Maastrichtian (Shrank, 1994, Mahmoud 2003).

CONCLUSION

The palynofloras of Ahoko /Ahoko Gbayi shale section of Patti Formation, Bida Basin, are overwhelmingly of terrestrial origin. They are dominated by angiosperms *(Monocolpollenites sp, Monocolpites marginatus, Echitriporites trianguliformis, Retistephanocolpollenites Williamsi).* Fungal spore and fruiting bodies and acritarchs *(Mirchystridium* and *Baltisphaeridium)* occur in minor amounts. The age of the formation based mainly on the angiosperm assemblage is Middle to Late Maastrichtian. The Palmae and Protecean pollen association is indicative of terrestrially derived plant materials which are deposited in a predominantly fluviatile environment.

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