



## Evidence of Campanian-Maastrichian palynomorphs from Lamja Formation, Yola Sub-basin, Northern Benue Trough, Nigeria

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### ABSTRACT

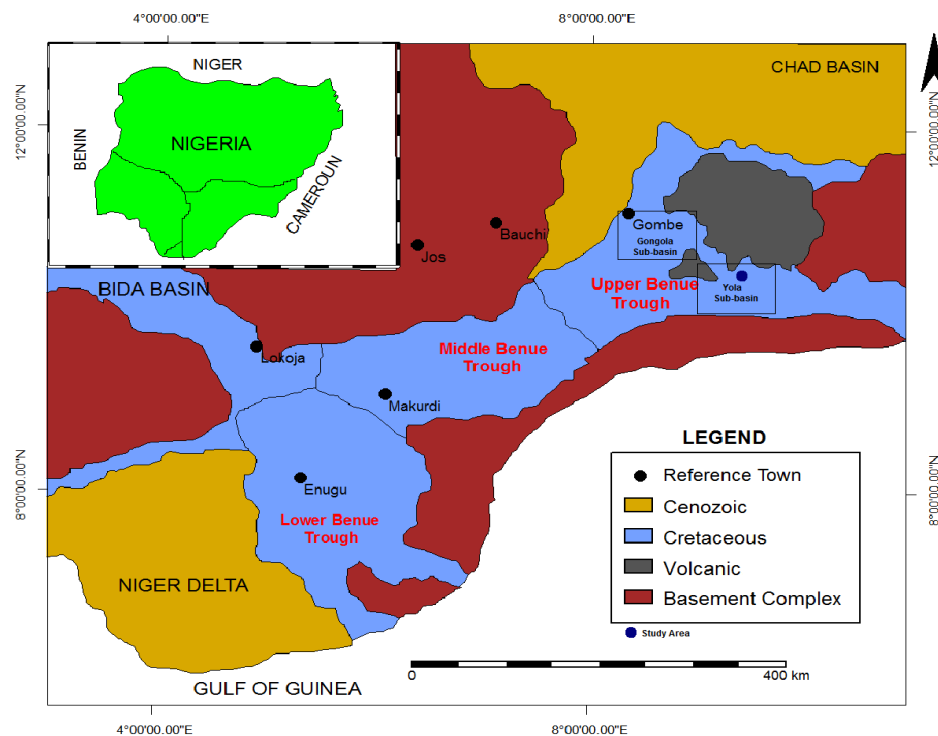
The Lamja Formation marks the end of sedimentation in the Yola Sub-basin of the Northern Benue Trough. The formation was assigned to the Upper Santonian age. However, recent palynological studies of samples from Lamja Formation recovered Campanian-Maastrichian palynomorphs that include the following palynomorphs species; *Monoporites annulatus*, *Logapertites marginatus*, *Proteacidites sigalli*, *Monocolpites marginatus*. This shows that there is a possibility of sedimentary deposition in the Yola Sub-basin immediately after the mid-Santonian tectonic inversion. However, the Campanian-Maastrichian palynomorphs species recovered in this study are similar and can be correlatable to other Cretaceous palynologic zones in the West Africa and South American basins.

**Keywords:** Maastrichian; Palynomorphs; Cretaceous; Lamja Formation; Yola Sub-basin

### INTRODUCTION

The Northern or Upper Benue Trough (Fig. 1) is divided into N-W trending Gongola Sub-basin and E-W trending Yola Sub-basin. The Lamja Formation is a Cretaceous formation that marks the end of sedimentation in the Yola

Sub-basin (Carter *et al.*, 1963). The formation consists of sandstone, shale and coal of delta origin (Sarki Yandoka, 2015) and was assigned to Santonian age based on the presence of *Droseridites senonicus* palynomorphs (Usman *et al.*, 2021).



**Figure 1:** Geological map of Benue Trough showing the study area (from Sarki Yandoka, 2015)

The sediments were earlier described under the name "Carbonaceous Beds" by Carter *et al.* (1963) and conformably overlies the Numanha Shales (Sarki Yandoka, 2015). The Northern Benue Trough presents a similar tectonic evolution and stratigraphy. It appears to be connected up to pre-Santonian period. The depo-belts shifted to the west during the Santonian tectonic inversion event in the Gongola Sub-basin, while the Yola Sub-basin area developed into an active erosional site from the

Santonian up to the present (e.g. Abubakar *et al.*, 2011; Sarki Yandoka, 2015). Thus, the Lamja Formation was assigned to the Upper Santonian age. However, there is still an existing controversy on the tentative age of the formation. The objective of this study is to present a new palynological evidence that signifies extension of deposition up to Campano-Maastrichian for the Lamja Formation of the Yola Sub-basin.

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## GEOLOGY

The Nigerian Benue Trough was formed during the Early Cretaceous rifting and strike-slip faulting or movement of the Central West African Basement Complex (Carter *et al.*, 1963; Benkhelil, 1989; Zarborski *et al.*, 1997). The trough extends NNE–SSW for about 800 km in length and 150 km in width (Obaje, 2009). The southern limit is the northern boundary of the Niger Delta, while the northern

limit is the southern boundary of the Chad Basin containing of Cretaceous – Tertiary sediments of which those predating the mid-Santonian have been compressionaly folded, faulted, and uplifted in several places. The Benue Trough is sub-divided into a Lower, Middle and Upper portions (Carter *et al.*, 1963). The Upper Benue Trough is made up of two arms, the Gongola and the Yola Sub-basins (Figs. 1 and 2).

Age	Gongola Arm	Yola Arm	Paleoenvironment	
Tertiary	Kerri - Kerri Formation	Erosion?	Continental (Fluvial / Lacustrine)	
Maastrichtian	Gombe Sandstone		Continental (Lacustrine / Deltaic)	
Companian		Pindiga Formation	Fika Shale	Lamja
Santonian	Deban Fulani		Numanha	
Coniacian	Gulani		Sekuliye	
Turonian	Dumbulwa		Jessu	
Cenomanian	Kanawa		Dukkul	
	Yolde Formation		Transitional	
Albian and older	Upper Bima Sandstone Member		Braided	Continental
	Lower Bima Sandstone Member		Alluvial/Braided Lacustrine	
Precambrian	Basement Complex		Igneous/Metamorphic	

Figure 2: Stratigraphy of Upper Benue Trough (modified after Tukur *et al.*, 2015)

The Bima Formation is the oldest Cretaceous succession in the Yola Sub-basin (Zarborski *et al.*, 1997). The formation was succeeded by the Cenomanian transitional sediments of Yolde Formation (Fig. 2) which pass upward into coastal shallow marine sequences of Dukul, Jessu and Sekuliye Formations, the Numanha Shale, and the Lamja Sandstone ranging in age from Turonian to Santonian. However, the Lamja Formation has a dominating marine delta lithology (Abubakar *et al.*, 2011; Sarki Yandoka, 2015).

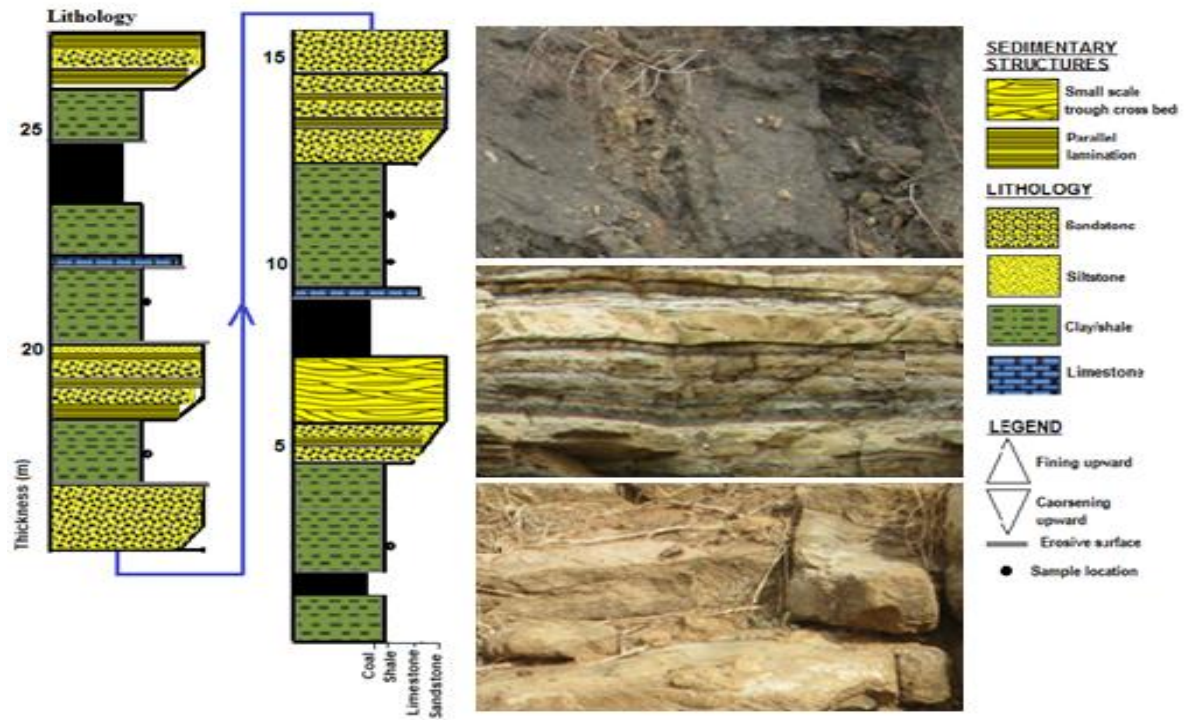
## METHODOLOGY

Field studies that involved description, measurements of sections and sampling was conducted, where ten (10) outcrop samples were collected (Fig. 3). Palynological sample preparation involved digestion with hydrofluoric acid (HF) to remove silicates followed by sieving through samples were collected from the exposed sedimentary section. Separation of macerals with heavy liquid was done using Zinc Bromide (ZnBr<sub>4</sub>), prior to mounting of the residue on glass slide with DPX. The prepared palynological slides were viewed under LEICA microscope with the aim of identifying and counting important palynomorphs such as pollen, spores, dinoflagellates, microforaminiferal wall lining, algae, and fungal spores present.

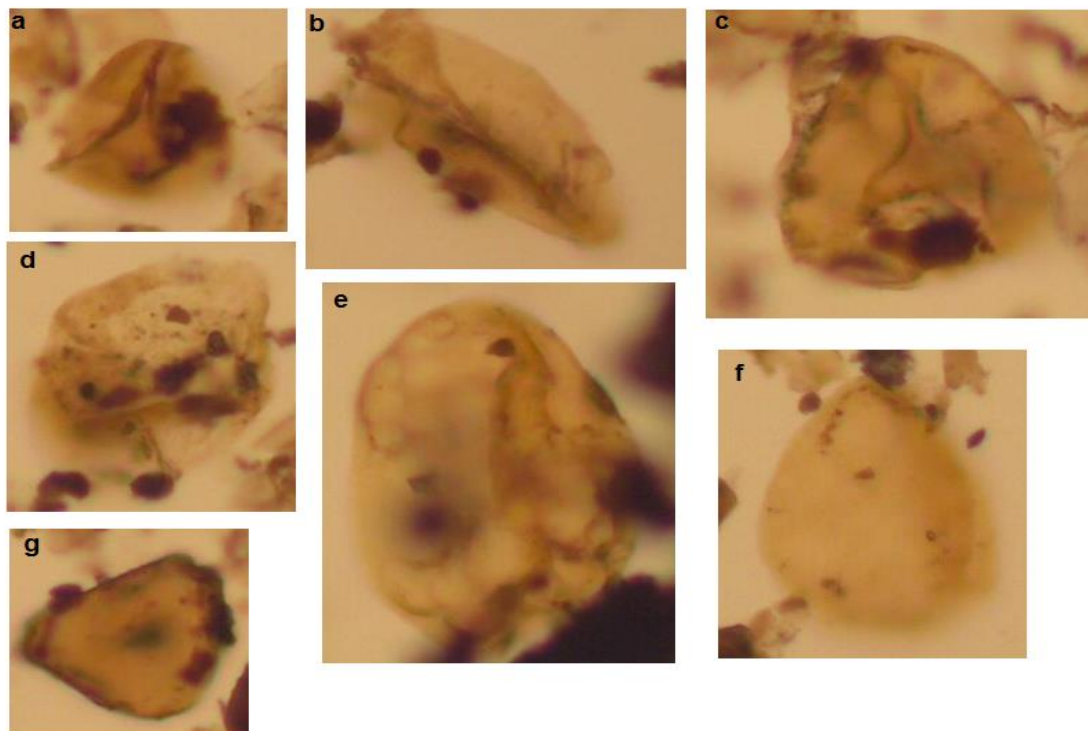
## RESULTS AND DISCUSSIONS

Some Upper Cretaceous palynomorphs species recovered from the Lamja Formation outcrop in the Yola Sub-basin include; *Monoporites annulatus*, *Logapertites marginatus*, *Proteacidites sigalli* (Boltenhagen 1978; Sensu 1989), *Monocolpites marginatus* (Vander Hammen, 1954) (Fig. 4). Lawal and Moullade (1986) have used a similar palynological assemblage *Monoporites annulatus* and *Monocolpites marginatus* to recognize the Campanian to Maastrichtian sections in Upper Benue Trough. This observation correlates with similar conditions reported for the Campanian-Maastrichtian sediments in the Gongola Sub-basin.

*Proteacidites sigalii* is regarded as a Maastrichtian species in Sudan (Eisawi *et al.*, 2012). It has also been recorded in the Maastrichtian of the Gedaref Formation of eastern Sudan (Eisawi and Schrank, 2009). This agrees with the findings that the Maastrichtian palynomorphs are present in the Lamja Formation. More so, *Monocolpites marginatus* sp. extends to Maastrichtian and known from the Maastrichtian of Nigeria, Egypt and Somalia (Schrank, 1994). In addition, *Monoporites annulatus* sp. occur in the Campanian–Maastrichtian of the Anambra Basin, Nigeria (Salami, 1990). Therefore, this reaffirms that depositional framework of deltaic Lamja Formation extends up to the Campanian–Maastrichtian based on the presence of palynomorphs and comparison with similar work within the West African Rift Basins



**Figure 3:** Lithostratigraphic section of Lamja Formation from Yola Sub-basin



**Figure 4:** Photomicrographs of the Campanian-Maastrichian palynomorphs species recovered from Lamja Formation (a) *Monoporites annulatus* (b) *Monocolpites marginatus* (c-d) same as in 'a', highly degraded (f) *Logapertites marginatus* and (g) *Proteacidites sigali*

## CONCLUSIONS

Palynological studies of Lamja Formation outcrop from Yola Sub-basin revealed some Campanian-Maastrichian palynomorphs species that include; *Monoporites annulatus*, *Logapertites marginatus*, *Proteacidites sigalli*, *Monocolpites marginatus*. Similar palynomorphs were earlier found in Maastrichian sediments within the West African Rift Basins. This work has for the first time, reported the palynological assemblages of Campanian-Maastrichian age within the lithostratigraphic units of the Yola Sub-basin. This reaffirms that there is a possibility of extension of sedimentary deposition after the mid-Santonian tectonic episode in the Yola Sub-basin. The identified species are similar and can be correlatable with the other Cretaceous palynological zones in the South American basins.

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