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OSTRACODS FROM THE YOLA ARM, UPPER BENUE TROUGH, NIGERIA

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ABSTRACT

A total of nine genera of ostracods from the Yola Arm in the north-east of Nigeria are described. The various species, though from outcrop sections, supplement the list from the Upper Benue Trough already reported from Ashaka quarry and borehole (BH 2340) of the Gongila and Pindiga Formations respectively. The species described belong to six families namely; *Brachicytheridae*, *Bythocytheridae*, *Cyprididae*, *Trachyleberididae*, *Cytherideidae* and *Cytherellidae*. Some of the species are evidence of faunal dispersion during the Mid-Cretaceous marine transgression of the North and West African basins.

KEYWORDS: Biostratigraphy, systematics, ostracod, taxonomy.

INTRODUCTION

Taxonomic and biostratigraphic data on ostracods in Nigerian basins are available in the works of Reyment (1960, 1963, 1966 and 1981), Swain et al. (1965) and particularly Okosun (1987, 1989, 1999 and 2001). The stratigraphic distribution spans from Upper Cretaceous to Paleogene with a large number of taxa derived from the Geological Survey of Nigerian boreholes (GSN-BH) located in Itori, Araromi, Nkalagu, Ashaka and Akata (Okosun, 1987) as well as Nigerian National Petroleum Corporation Kinasar-I borehole drilled near Maiduguri (Okosun, 1992). Ostracod assemblages from the Upper Benue Trough were from Ashaka-1 borehole (GSNBH-1184) located in the Gongola Arm, but none was reported from the Yola Arm of the Trough. This work presents the distribution and systematics of the ostracod species from the shale beds of the outcrops of some marine formations in the Yola Arm.

OUTLINE GEOLOGY AND LITHOSTRATIGRAPHY OF THE STUDY AREA

A geodynamic process of basin formation was adduced to the evolution of the Benue Trough during the Early Cretaceous crustal rifting that produced the Atlantic marginal basins (Guiraud, 1992). The Yola Arm evolved as an E-W extension of the trough linking other rifted crustal network of West/Central African rifted basins (Fig. 1).

The earliest sedimentary deposit on the floor of the rifted basin was the Aptian-Albian Bima Sandstone. It unconformably overlies the Precambrian Basement and consists of variable textures, on account of facies changes emanating from fluvial and lacustrine depositional environments. This basal unit was succeeded by post-Albian Yolde, Dukul, Jessu, Sukuliye, Numanha and Lamja, which were deposited as a result of sedimentation in the paleo-sea that inundated the rifted basin (Table 1).

The Aptian-Albian Bima Sandstone that constitutes the basal lithounit of the entire basin reflects the syntectonic deposition of the sediments as the basin evolved (Guiraud, 1990). The earliest sediments were fanglomerates deposited at the fault margins of the rifted basin. Along the traverse toward the basins axis, the fanglomerates wedge against braided river and lacustrine deposits. The fanglomerates are characterized by angular clasts embedded in fine grain matrix. The braided stream deposits are composed of basal channel pebble lags, overlain by trough cross-bedded sandstone while the lacustrine deposits consists of fine grained sandstone with oblique planner cross stratification. The latter forms the domineering primary structure in the outcrops of Bima Sandstone of the Yola Arm. The overlying Yolde Formation is composed of well sorted fine to medium grained clean sandstone suggestive of beach environment. The thin to medium bedded sandstone are often intercalated with subordinate limestone, shale and mudstone. The succeeding units are post-Cenomanian marine stages of Dukul, Jessu, Sukuliye, Numanha and Lamja which are all restricted in occurrence within the Dadiya Syncline – a major tectonic structure within the basin (Fig. 2). Among the formations, only the Dukul, Sukuliye and Numanha yield ostracods in their shale interbeds (Fig. 3). The Dukul Formation was sampled at a section along a stream channel, 200m away from the village primary school. The Sukuliye Formation was sampled from a section exposed at dug-up pits located in Gundanyu and Sukuliye villages while ostracods were derived from Cimdauye, Gwolitse and Ayatse sections for the Numanha Formation.

METHODOLOGY

Samples were taken from each of the shale interbeds of outcrops representing the various formations in the basin. About 100g of each sample was soaked with Na_2CO_3. The content was then washed through a 63µm sieve and the residue oven-dried. Ostracods were picked from the residue, using an OLYMPUS binocular microscope. The identification of the recovered species was aided with Scanning Electron Microscopic study at the Federal Institute of Science and Raw Material Laboratory in Hanover, Germany.

BIOSTRATIGRAPHY

In this study, a total number of nine genera belonging to six families of Podocopids are recovered from the shale beds of Dukul, Sukuliye and Numanha Formations (Table 2). The genera are *Brachycythere*, *Bythoceratina*, *Bythocypris*, *Cythereis*, *Cytherella* *Dolocytheridea*, *Dumontina*, *Ovocytheridea* and *Paracypris* (Plate 1). Species of *Ovocytheridea reniformis* and *Cytherella comachensis* occur in the three formations, while *Bythoceratina*, *Bythocypris*, *Dumontina* and *Ovocytheridea ashakaensis* are restricted to Numanha Formation. With the highest ostracod count in the shale beds of Ayatse section, the Numanha Formation exhibits

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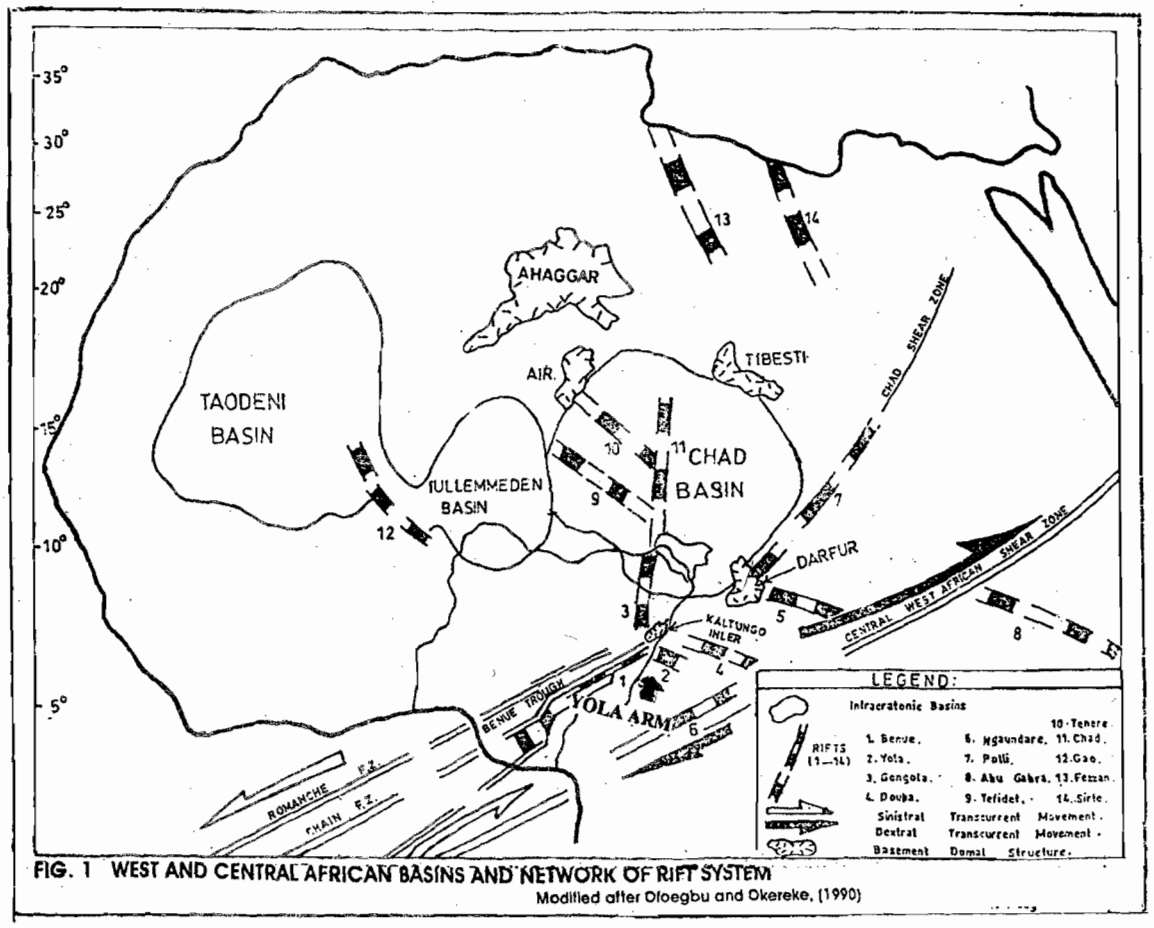


FIG. 1 WEST AND CENTRAL AFRICAN BASINS AND NETWORK OF RIFT SYSTEM
Modified after Ofoegbu and Okereke, (1990)

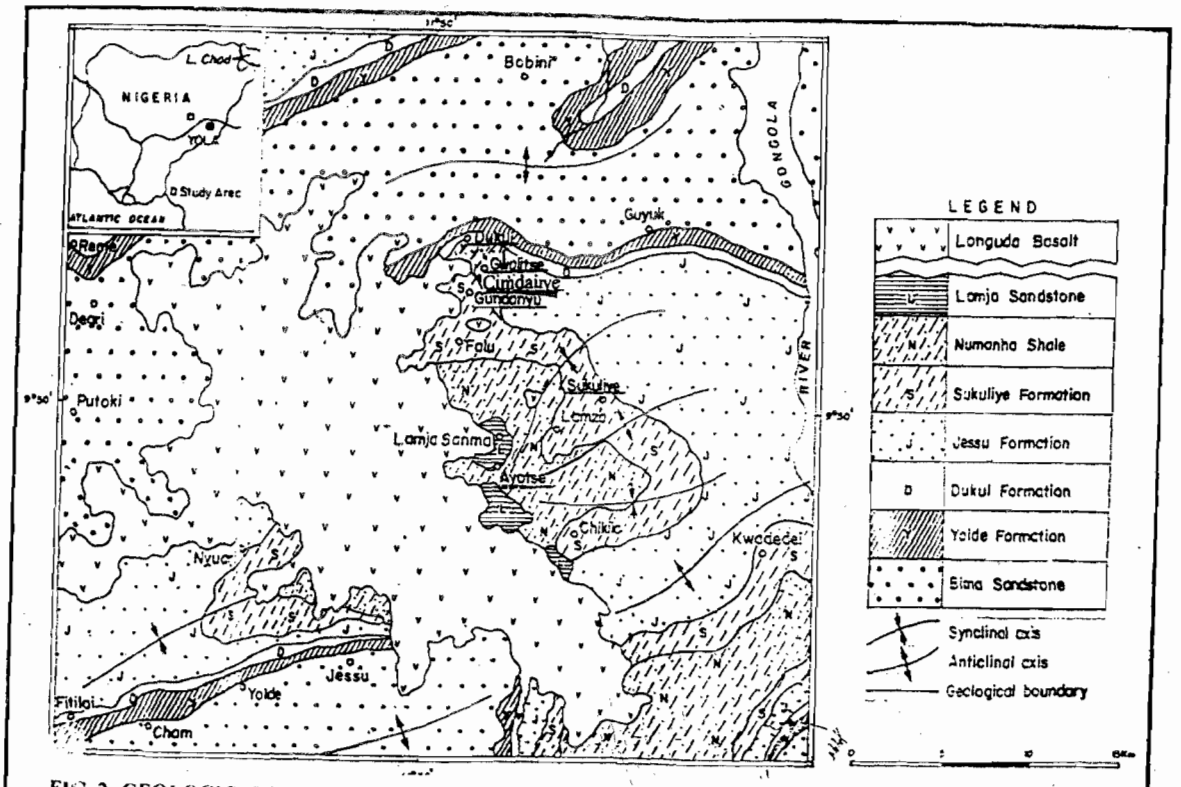


FIG. 2: GEOLOGICAL MAP OF NORTH-EAST DADIYA SYNCLINE
Drawn from Carter et al. (1963)

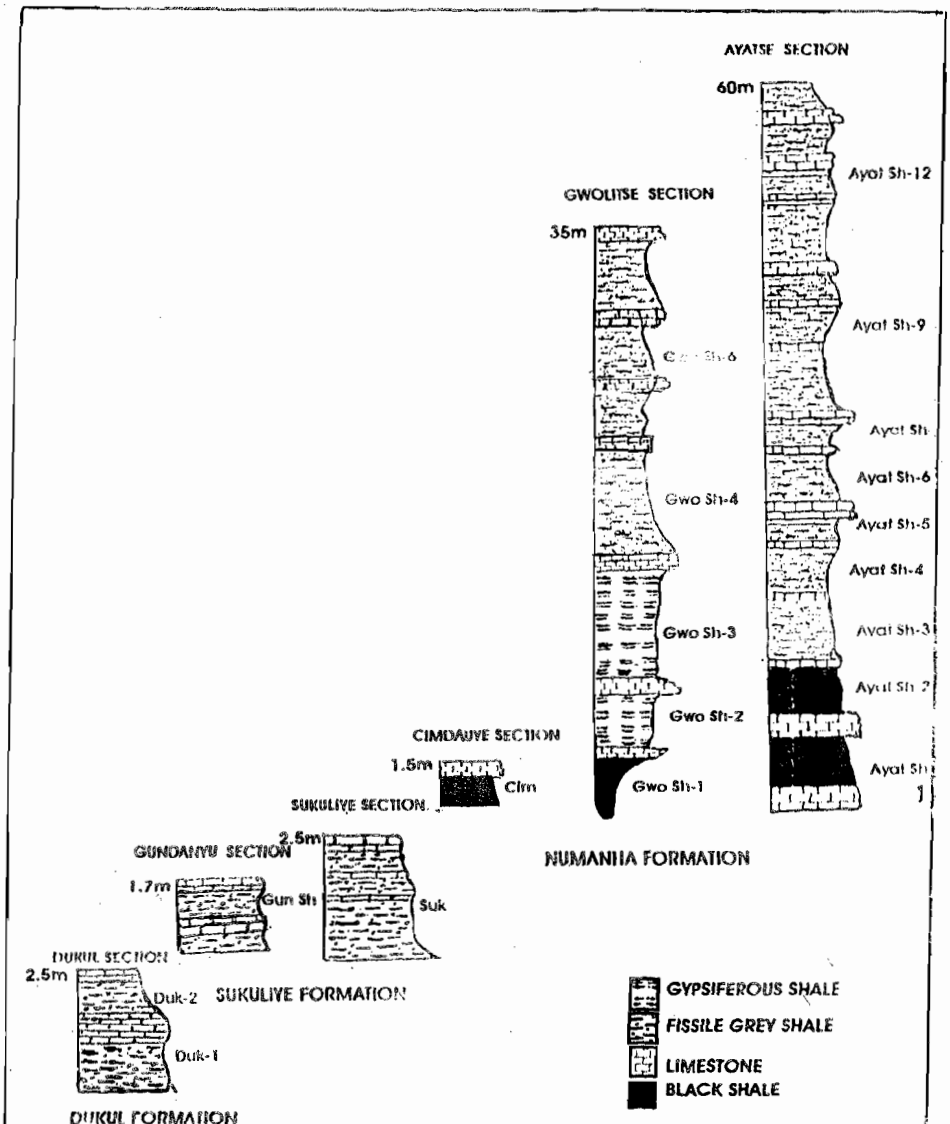


FIG 3: LITHOLOGS AND SHALE-BED SAMPLE POINTS FROM WHERE OSTRACODS ARE DERIVED IN THE DUKUL, SUKULIYE AND NUMANHA FORMATIONS

the highest relative diversity of forms with abundance of *Ovocytheridea reniformis* (Fig. 4).

PALEOECOLOGY

Rhythmically interbedded limestone and shale has been attributed to storm-current induced sedimentation with deposition occurring below wave base (Opeloye, 2002). Climatic fluctuation, in which occasional run off causes influx of siliciclasts into a warm carbonate depositing condition, was also equally attributed by Dott (1964), as the cause of short period occurrence of the rhythm common in many Cretaceous to Eocene rhythmic depositions. The former is however, related to the effect of fluctuation of marine influence on the shoreline typical of the shallow epeiric sea.

Recovered taxa from the shale interbeds, are well preserved with an enhanced carapace-valve ratio that reflects rapid sedimentation in the agitated basin. The ostracods are the smooth surface forms except *Cythereis vitiliginosa reticulata* and *Dumontina* sp. The majority of the smooth forms are Cytheredeids with abundant species of *Ovocytheridea* which indicate prevailing shoreline ecology, especially the marginal lagoonal environment. Attainment of full marine condition is inferred in the Lower Turonian Dukul deposit with the presence of ornamented species of *Dumontina* and *Cythereis* sp. in the assemblage. Nevertheless, the abundance and relative diversity of Cytheredeids together with hypersaline Cytherallids (*Cytherella comachensis*) as well as hyposaline Cyprideids (*Bythocypris.* and *Paracypris* spp.) emphasizes the nature of the prevailing brackish depositional environment.

PALEOBIOGEOGRAPHY

Ostracods are generally regarded as restricted in their mode of dispersal due to their benthic nature but on the contrary the Mid-Cretaceous transgression provided the interregional correlation of beds within the intracontinental basins of Africa. Studies of the paleogeography of ostracods in the North and West African basins by Okosun (1992) and Gebhardt (1999) allow for the following grouping of the studied ostracods into three forms that signify that the Yola Arm constitutes a passage of sea inundation at different instances:

Group 1: Forms that were involved in dispersal during the Cenomanian-Turonian continental inundation of the Gulf of Guinea and the Tethys sea. They are *Cytheres vitiliginosa reticulata*, *Ovocytheridea reniformis*, *Paracypris*, *Bythocypris* and *Brachycytheridea* spp. which constitute common forms in the basins of North and West Africa due to

AGE	FORMATIONS	SECTIONS/SAMPLES		Brachycythere sapucariensis	Bythoceratina sp.	Bythocypris sp.	Cythere vitiliginosa reticulata	Cytherella comachensis	Dolocytheridea sp.	Dumontina sp	Ovocytheridea ashakaensis	Ovocytheridea reniformis	Ovocytheridea symmetrica	Paracypris sp.
CONIACIAN	NUMANHA	AYATSE	Ayat sh-12										1	
			Ayat sh-9											
			Ayat sh-7									1		
			Ayat sh-6										1	
			Ayat sh-5								3			
			Ayat sh-4						4					
			Ayat sh-3											
			Ayat sh-2								10		16	
			Ayat sh-1		2		1	2	5		4			4
		GWOLITSE	Gwo sh-6											
			Gwo sh-4					2	7					
			Gwo sh-3										10	
			Gwo sh-2					3						
			Gwo sh-1	1	1	2			2					
		CIMDAUYE	Cim	2	2			2	9	2	4	18	5	2
	SUKULIYE	SUKULIYE	Suk					6				2	4	
		GUNDANYU	Gun-sh						4			14		
LOWER TURONIAN	DUKUL	DUKUL	Duk-2									7		
			Duk-1	2			2	3				5		

FIG. 4 OSTRACOD DISTRIBUTION CHART IN THE YOLA ARM OF UPPER BENUE TROUGH

the merging of the sea at the peak of transgression.

Group 2: Forms that were derived only from the Gulf of Guinea and therefore are endemic in West African basins. They are *Ovocytheridea symmetrica* and *Dumontina* sp. and they mark the period of regression when the northern limit of the Gulf of Guinea was not beyond the Yola Arm.

Group 3: Forms that were known to be typical of North African basins. They are *Bythoceratina* and *Dolocytheridea* sp. which equally mark the period of regression when the southern limit of the Tethys sea was not beyond the Yola Arm.

CONCLUSION

Ostracods derived from the shale beds of formation in the Yola Arm were examined and studied. Identified species are *Brachycythere sapucariensis, Bythoceratina* sp., *Bythocypris* sp., *Paracypris nigeriensis, Cythereis vitiliginosa reticulata, Cytherella comachensis, Dumontina* sp., *Ovocytheridea ashakaensis, O. reniformis, O. symmetrica and Dolocytheridea* sp. The majority of the forms are Cythereids and Cytherellids which are shoreline forms but the presence of Trachyleberids (*Cythereis* and *Dumontina* sp) as well as *Bythoceratina* sp. in some of the assemblage indicate that the paleoenvironment fluctuate between shoreline and normal marine condition.

Strong evidence that Yola Arm was situated within the inundated basins during the mid-Cretaceous transgression is particularly provided by the presence of *Cythereis vitiliginosa reticulata, Dumontina* sp, *Paracypris nigeriensis and Ovocytheridea reniformis.* These species were involved in regional faunal dispersal, as they attained their acme in the Cenomanian – Coniacian basins in Morocco, Tunisia, Egypt, Gabon as well as the Upper and Lower Benue Trough in Nigeria. However occurrences of Guinean forms not known in the North African basins and North African forms not known in the West African basins suggest the separation of both sea ways with the barrier lying in the Upper Benue, most likely the Zambuk ridge.

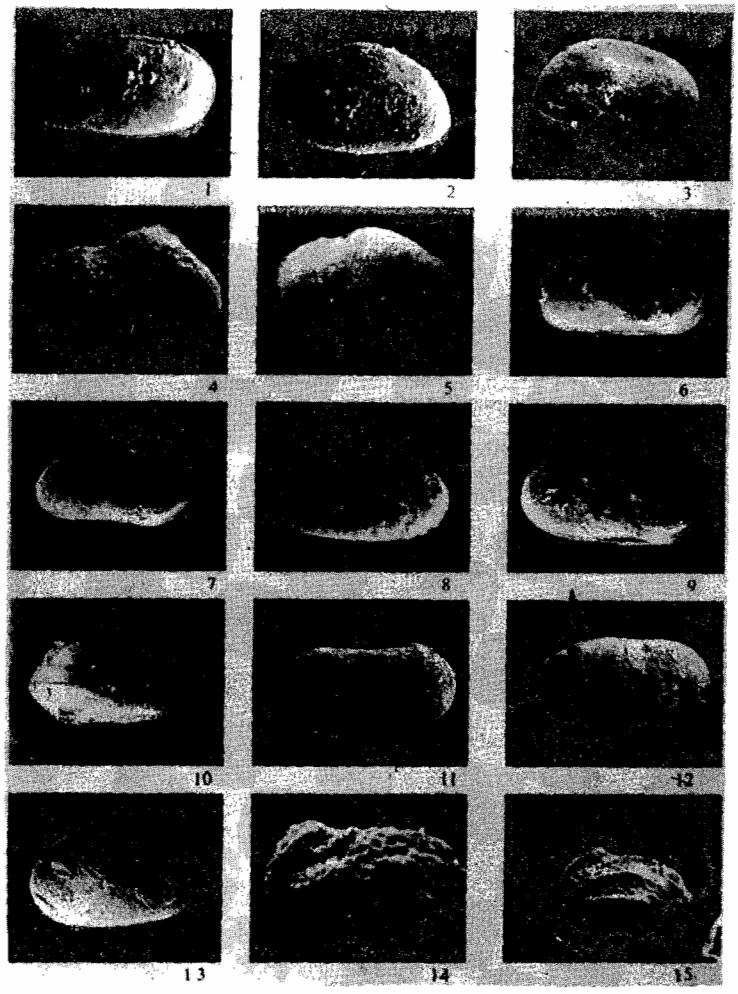
TABLE 1: STRATIGRAPHY OF THE YOLA ARM

AGE	YOLA ARM STRATIGRAPHIC UNITS
MAASTRICHTIAN	
CAMPANIAN	
SANTONIAN	
CONIACIAN	Lamja Sandstone / Numanha Shale / Sukuliye Formation
TURONIAN	Jessu Formation / Dukul Formation
CENOMANIAN	Yolde Formation
ALBIAN-APTIAN	Bima Sandstone

TAXONOMIC NOTES

Taxonomic accounts of the ostracods encountered

PLATE 1



1.*Dolocytheridea* sp. 2 *and* 13 *Ovocytheridea reniformis* 3. *Ovocytheridea symmetrica* 4,5 *and* 7 *Ovocytheridea* sp. 6,9and12 *Cytherella comanchensis* 8. *Bythocypris* sp. 0. *Ovocytheridea ashokaensis* 11. *Bythoceratina* sp. 14. *Cytherels vitiliginosa reticulata* 15. *Dumontina* sp.

OSTRACODS OF THE YOLA ARM

are presented below. The systematic descriptions of the species follow the monographs and methods employed by Okosun (1987, 1992 and 2001). The recovered taxa are identified through examination of the external features of the carapace and comparison with the published illustrations. Examination of the species internal features of the dentitions and muscle scars could not be achieved due to low magnification of the available optical microscope.

Phylum: ARTHROPODA Siebold and Stannius, 1845
Class: CRUSTACEA Pennant.
Sub-class: OSTRACODA Latrielle, 1806
Order: PODOCOPIDA Muller, 1894
Family: BRACHYCYTHERIDAE Puri, 1957
Genus: *Brachycythere*Alexander, 1933

Brachycythere sapucariensis

Krommelbein, 1964 Locality of Occurrence (sample no):Gwolitse section (Gwo Sh – 1), Numanha Formation Cimdauye section (Cim Sh – 1), Numanha Formation.
Dukul section (Duk – 1), Dukul Formation Description: Smooth, elongate and sub-triangular carapace with slightly convex dorsal and slightly concave ventral margins.
The dorso-ventral margins reveal a slight overlap of the right valve by the left valve.
Reported Occurrences: Nkalagu borehole (Okosun 1987) Gabon (Neufville, 1973) NE. Brazil (Krommelbein, 1975) Tunisia (Bismuth et al, 1981).

Family: BYTHOCYTHERIDAE Sars, 1926
Genus: *Bythoceratina*, Hornibrook, 1953
Bythoceratina sp. (plate 1, fig. 11)
Locality of Occurrence (sample no.): Ayatse section (Ayat-sh – 1), Numanha Formation
Cimdauye section (Cim – 1), Numanha Formation.
Gwolitse section (Gwo – 1), Numanha Formation
Description: Carapace is sub-rectangular in lateral view. The valves have straight
dorsal margins.
Reported Occurrences: Gboko Limestone, Nigeria (Okosun, 1994)

Family: CYPRIDAE Baird, 1845
Genus: *Bythocypris* Brady, 1880
Bythocypris sp. Plate 1, fig. 8
Locality of Occurrence (sample no.): Gwolitse section (Gwo-

TABLE 2: LIST OF OSTRCODS IN DUKUL, SUKULIYE AND NUMANHA FORMATIONS

NUMANHA FORMATION	*Brachycythere sapucariensis* *Bythoceratina* sp. *Bythocypris* sp *Paracypris* sp *Dolocytheridea* sp. *Cythere vitiliginosa reticulata* *Cytherella comachensis* *Dumontina* sp *Ovocytheridea reniformis* *Ovocytheridea* sp *Ovocytheridea ashakaensis* *Ovocytheridea symmetrica*
SUKULIYE FORMATION	*Ovocytheridea* sp *Paracypris* sp *Cytherella comachensis* *Dolocytheridea* sp. *Ovocytheridea reniformis* *Brachycythere sapucariensis* *Ovocytheridea symmetrica*
DUKUL FORMATION	*Brachycythere sapucariensis* *Cythere vitiliginosa reticulata* *Ovocytheridea reniformis* *Cytherella comachensis*

sh – 3) , Numanha Formation
Description: The carapace is elongate and compressed. The left valve overlaps the right valve dorsally and ventrally.
Remark/Reported Occurrences: *Bythocypris eskeri* (Bassiouni and Luger, 1990) has been associated with the Cenomanian – Turonian beds in the Egypt Basin. Earliest reported form in Nigeria was Paleocene
Bythocypris olaredodui and *B. alejoi*.

Genus: *Paracypris* Sars, 1866 (not illustrated in the Plate)
Locality of Occurrence (Sample no.): Ayatse section (Ayat-sh – 1), Numanha Formation.
Sukuliye section (Suk), Sukuliye Formation
Description: Carapace is smooth and sub-triangular. The dorsal margin is convex while ventral margin is slightly concave. The anterior is broadly rounded and the posterior narrowly pointed. The left valve overlaps the right valve at the dorsal and ventral margins.
Reported Occurrences: Campanian beds of Abu Rawash Basin, Egypt, (Van den Bold, 1964), Paleocene Sirte Basin, Libya, (Barsotti, 1963), Turonian Eze Aku (Reyment, 1963)
Family: TRACHYLEBERIDIDAE
Genus: *Cythereis* Jones, 1849

Cythereis vitiliginosa reticulata (Plate 1, fig. 14)
Locality of Occurrence (Sample no):
Ayatse section (Ayat sh – 1), Numanha Formation.
Dukul section (Duk – 1), Dukul Formation
Description: The carapace is ornamented and lined laterally with ridges. It is ovoid in shape. The dorso-ventral margins are straight and broad. The anterior is also broadly rounded while the posterior is triangular.
Reported Occurrences: Cenomanian – Turonian beds in Gabon (Neufville, 1973) and Turonian beds of Benue Trough, Nigeria (Okosun, 1985)

Family: CYTHERELLIDAE
Genus: *Cytherella* Jones, 1849

Cytherella comanchensis Alexander, 1929
Locality of Occurrence (Sample no):
Ayatse section (Ayat Sh-1, Sh-2, Sh-3), Numanha Formation.
Cimdauye section (Cim) Numanha Formation.

Gwolitse section (Gwo Sh-2, Sh-4) Numanha Formation
Sukuliye section (Suk) Sukuliye Formation.
Dukul section (Duk-2) Dukul Formation.
Description: The carapace is elongate and elliptical in outline from the side view. The anterior and posterior margins are rounded and the dorsal and ventral margins are straight, but the former is slightly oblique resulting in the relatively narrow anterior.
Reported Occurrences: Washita Group, Texas, U.S.A; and Gongila Formation, Benue Trough, Nigeria (Swain et al. 1995)

Genus: *Dumontina* Deroo, 1966
Dumontina sp. (Plate 1, fig. 15 – Left side of carapace).
Locality of Occurrence (Sample no.): Cimdauye section (Cim), Numanha Formation.
Description: *Dumontina* sp. is ornamented with 3 sub-parallel ridges running laterally along the carapace. Carapace has broadly rounded anterior margin and a narrowly pointing posterior end, which makes the genus sub-rectangular in shape. The right valve is overlapped by the left valve.
Reported Occurrences: Turonian Pindiga of NE Nigeria (Okosun, 1987)
Family: CYTHERIDIDAE Sars, 1925
Genus: *Ovocytheridea* Grekoff, 1957

Ovocytheridea ashakaensis Okosun, 1987
(Plate 1, fig. 10 – Right side of carapace).
Locality of Occurrence (Sample No.): Ayatse section (Ayat – Sh-2, Sh-5) Numanha Formation.
Cimdauye section (Cim) Numanha Formation.
Gwolitse (Gwo – sh-1), Numanha Formation
Description: Carapace is smooth and oval with strongly convex dorsal margin and weakly convex ventral margin. The anterior end is broad while the posterior margin is obliquely rounded. The left valve overlaps the right valve and the overlap forms projection on the right valve.
Reported Occurrences: The species was first described by Okosun (1987) from Ashaka borehole in the Pindiga Formation of the Upper Benue Trough, Nigeria.

Genus: *Ovocytheridea reniformis*
(Plate 1, fig. 6 & 9 – Right side of carapace)
Locality of Occurrence: Dukul section (Duk-1 and 2), Dukul Formation.
Gundanyu section (Gun – sh-1), Sukuliye Formation.
Cimdauye section (Cim), Numanha Formation.
Description: The carapace is smooth and inflated with weakly convex dorsal and ventral margin. The anterior is more broadly rounded than the posterior.
Reported Occurrence: Abu Ravash basin of Egypt (Van den Bold, 1964) Cenomanian – Turonian beds of Gabon (Neufville, 1973), Eze Aku Formation, Nigeria (Okosun, 1987)

Genus: *Ovocytheridea symmetrica*
(Plate 1, fig. 3 – Left side of carapace)

Locality of Occurrence (Sample No.): Gwolitse section (Gwo – sh-3), Numanha Formation.
Cimdauye section (Cim), Numanha Formation.
Ayatse section (Ayat – sh-2), Numanha Formation.
Sukuliye section (Suk), Sukuliye Formation.
Description: The carapace is smooth and oval and has antero-ventral flattened border on the right valve.
Reported Occurrence: Cenomanian – Turonian beds of Gabon (Neufville, 1973) Eze Aku Formation (Okosun, 1987) Pindiga Formation (Okosun, 1987)

Genus: *Dolocytheridea* Triebel, 1938

Dolocytheridea sp.(Plate 1, fig. 1 – Right side of carapace)
Locality of Occurrence (Sample No.): Ayatse section (Ayat Sh-1, Ayat Sh-4), Numanha Formation.
Gwolitse section (Gwo – sh-4), Numanha Formation.
Cimdauye section (Cim), Numanha Formation.
Gundanyu section (Gun – 1), Sukuliye Formation.
Description: The carapace is smooth and sub-triangular. The dorsal margin is convex, obliquely running towards the ventral margin at the posterior end. The anterior margin is broad and rounded. The posterior is narrow and sharply rounded, while the ventral margin is straight.
Reported Occurrences: Turonian – Santonian Fika Shale, Chad Basin, Nigeria (Okosun, 1992).

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