CRETACEOUS AND EOCENE MICROFOSSIL AGES FROM THE SOUTHERN BENUE TROUGH, NIGERIA[1]

BY

K. PERCH-NIELSEN,[2] S. W. PETTERS[3]

ABSTRACT

An appraisal of the biostratigraphic value of microfossils in the Benue Trough affirms the suitability of calcareous nannofossils and planktic foraminifera for age determination of the fully marine stratigraphic levels. Thus, the Awgu Formation is dated as Turonian (?) along the Enugu-Port Harcourt expressway, Coniacian (?) along the Calabar-Itu road, and Early Coniacian in the Nkalagu quarries. The exposure of the Ameke Formation along the Enugu-Port Harcourt expressway contains early Eocene planktic foraminifera and late Early to early Middle Eocene coccoliths.

INTRODUCTION

Calcareous nannofossils and planktic foraminifera are used in this article to establish the ages of two important marine levels in the southern Benue Trough (fig. 1). The Benue Trough is an intracratonic rift basin that extends from the Gulf of Guinea in the southeast through the Nigerian Shield and links with the Chad Basin in the northeast. About 5,000 m of lower Lower and Upper Cretaceous deposits fill the southern part of the Benue Trough. These deposits comprise shallow epicontinental shales and limestones in the central parts of the basin and paralic sandstones along the margins of the basin. The Awgu Formation, on account of its high fossil content, represents the deepest marine Cretaceous deposit in the southern Benue Trough. While the rest of the Benue Trough has been emergent since Early Tertiary times, clastic sedimentation continued in the south in the Niger Delta. Outcropping along the northern flanks of the Niger Delta are shallow shelf clastic Paleogene beds of which the Eocene Ameke Formation (fig. 1) appears to be the most marine in the exposed part in eastern Nigeria. Since the Niger Delta is located in the southern, oceanward extension of the Benue rift, the Ameke Forma-

[1] Contribution to IGCP Project No. 145.
[2] Geologisches Institut, Eidg. Technische Hochschule, Zurich, Switzerland.
[3] Department of Geology, University of Ibadan, Ibadan, Nigeria.

tion may be considered as the youngest exposed marine cycle in the Benue Trough.

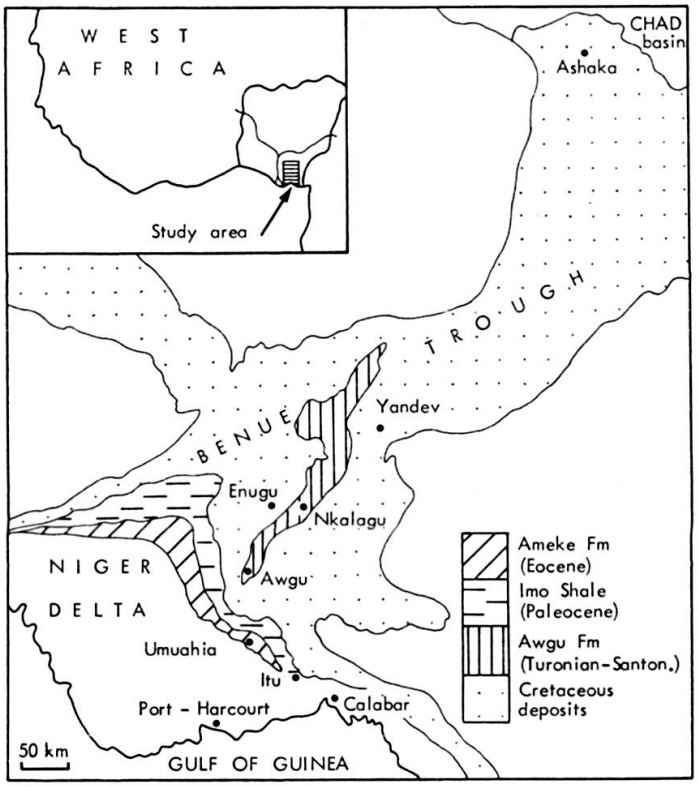

FIG. 1. — Outline map of the Benue Trough showing the Awgu and Ameke Formations and sample localities.

The sedimentary fill of the Benue Trough was influenced by five major paleo-oceanographic events in the South Atlantic Ocean (REYMENT, 1980), namely:

(1) Late Middle Albian shallow marine connexion between the North and South Atlantic Oceans and initial flooding of the southern Benue Trough,

(2) Late Cenomanian to Early Turonian transgression which swamped marginal areas of the Gulf of Guinea and extended marine influence into the northern parts of the Benue Trough,

(3) Late Turonian to Early Santonian transgression during which fully oceanic conditions were established in the Gulf of Guinea and the Awgu Formation was deposited in the southern Benue Trough,

(4) Late Campanian to Early Maastrichtian transgression that swamped the southern Benue Trough wherein coal beds accumulated,

(5) the circulation of deep and well oxygenated water during the Paleogene and the deposition of the Ameke Formation in the southern Benue Trough.

The recovery of common calcareous nannofossils and planktic foraminifera from the Awgu and Ameke Formations is therefore due to the prevalence of fully marine conditions in the southern Benue Trough during the deposition of these beds. Other stratigraphic levels which were sampled in quarries at Ashaka and Yandev were either devoid of calcareous nannofossils and foraminifera or extremely poor. In the Ashaka quarry the Fika Shale Formation of Late Cretaceous age (CARTER et al. 1963) contained *Heterohelix sp.*, *Guembelitria sp.* and arenaceous foraminifera, but no coccoliths. At Yandev the alternating limestone and shale sequence of probably Albian age contains the benthonic foraminiferal species *Gavelinella sp.*, and only very rare coccoliths, mainly *Watznaueria barnesae*, a species that ranges from Mid Jurassic through the Cretaceous. *Thoracosphaera*, a calcareous dinoflagellate which is often found in sediments which were deposited under non-normal marine conditions was also found in the Yandev profile. The paucity of planktic microfossils at Ashaka and Yandev is due to the deposition of these beds towards the limits of the marine transgressions which came from the Gulf of Guinea in the South and shoaled northeastwards where abnormal marine conditions prevailed (PETTERS, 1978).

The calcareous nannofossils were studied in smearslides with a light microscope (occulars 12.5 and objective 100x with oil immersion). This allows the determination of most coccoliths larger than 2 to 3 microns, but makes the finding of very rare larger forms rather difficult. Among the assemblages studied, the samples from the Eocene Ameke Formation would certainly be worth a closer look and a monographic study to allow detailed comparisons with contemperaneous assemblages from both, other low latitude and and high latitude shelf and open ocean environments. Closer study would also be beneficial in the case of the Middle Cretaceous samples from the Awgu Formation in Nkalagu, where *Marthasterites furcatus* is very well developed and common.

AWGU FORMATION

The Awgu Formation, about 900 m thick, comprises bluishgrey and black well-bedded shales with limestone and sandstone intercalations (DESSAUVAGIE, 1975; REYMENT, 1965). Fresh exposures of the Awgu Formation occur in quarries at Nkalagu, in roadcuts along the new Enugu-Port Harcourt expressway, and along the Calabar-Itu road.

The profiles exposed in the Nkalagu limestone quarries consist of massive limestone at the base overlain by highly fossiliferous, calcareous, micaceous, dark grey shales with *Inoceramus* impressions along the shale bedding planes, and intercalations of limestone and marl (fig. 2). The Nkalagu profiles were dated Early Turonian on ammonite evidence (ARUA & RAO, 1978; REYMENT, 1965), and also on the basis of foraminifera (FAYOSE & DE KLASZ, 1976) and ostracodes (NEUFVILLE, 1973),

but MURAT (1972) correlated these profiles with the Late Turonian and PETTERS (1980) preferred an Early Coniacian age.

The diversity of heterohelicid planktonic foraminiferal species in the Nkalagu quarries with forms such as *Heterohelix striata*, *H. reussi*, *H. planata*, and *H. pulchra*

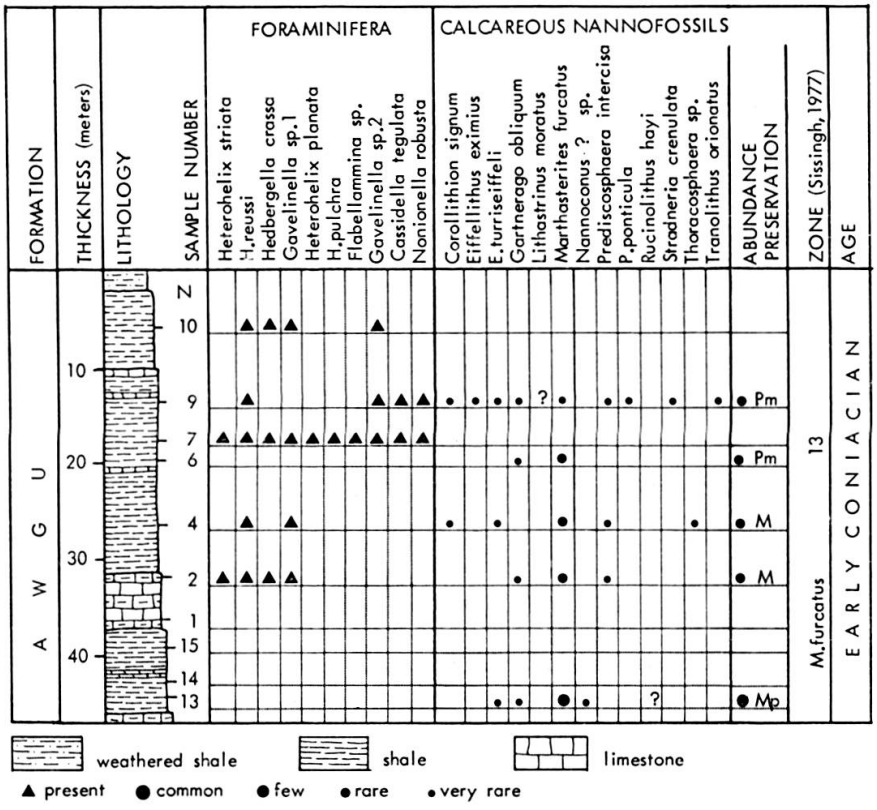

FIG. 2. — Distribution of planktic microfossils in the Awgu Formation exposed in a quarry at Nkalagu.

(fig. 2) favours Senonian age while the association of *Marginotruncana renzi*, *M. difformis* and *M. sigali* (PETTERS, 1978) correlates the Nkalagu profiles with the Late Turonian-Early Coniacian *Globotruncana renzi* — *G. sigali* Range Zone of VAN HINTE (1976). The Nkalagu foraminiferal assemblage was recently illustrated in PETTERS (1980).

The coccolith assemblage at Nkalagu belongs to the *Marthasterites furcatus* Zone (13 of SISSINGH, 1977) and is dominated by *M. furcatus* in association with *Watznaueria barnesae*, *Prediscosphaera intercisa* and *Gartnerago obliquum*. The latter are somewhat smaller — about 8 microns — than in many European sections. The *M. furcatus* Zone is assigned to the Early Coniacian, the coccolith age assignement thus supporting the foraminiferal indicators of an Early Coniacian age for the Awgu Formation in the Nkalagu quarries.

On the Enugu-Port Harcourt expressway, near Awgu town, about 47 km to the new expressway — old Umuahia road junction, are small roadcuts through the

Awgu Formation. Here are exposed black and pale grey flaggy shales with marl nodules (fig. 3). The association of the Early Turonian planktic foraminiferal species *Lunatriella spinifera* (EICHER & WORSTELL, 1970), the Turonian-Santonian species *Hedbergella crassa* (BOLLI, 1959), the Turonian-Campanian form *Heterohelix reussi*

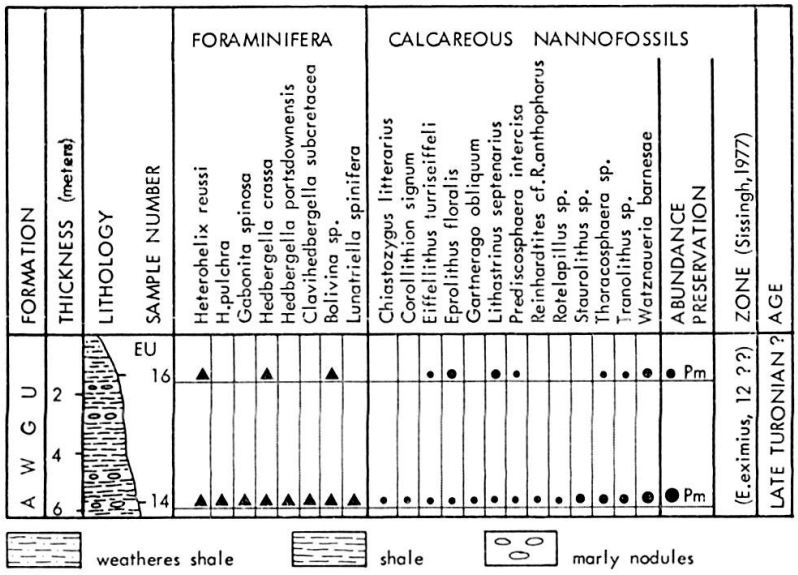

FIG. 3. — Distribution of planktic microfossils in the Awgu Formation exposed in a roadcut on the Enugu-Port Harcourt expressway, 47 km before the expressway — old Umuahia road junction.

(PESSAGNO, 1967; PETTERS, 1977), together with *Gabonita spinosa* of Senonian age (DE KLASZ & RERAT, 1963) suggests at most Turonian-Santonian age. However, the presence of *Lunatriella spinifera* and the absence of *Marthasterites furcatus* and *Eiffellithus eximius* from the coccolith assemblage suggest an Early Turonian age for this part of the Awgu Formation. On the other hand, the presence of the Senonian *Gabonita spinosa* and *Lithastrinus septenarius* (Coniacian-Santonian) would suggest a younger age. A compromise is expressed on fig. 3, with the questionable assignement to zone 12 of SISSINGH (1977), which is defined from the first occurrence of *Eiffellithus eximius* to the first occurrence of *M. furcatus*. *E. eximius* was not found, but it is also only very rare together with *M. furcatus* in one of 5 samples in the Nkalagu profile, and thus is not a reliable marker in this part of the world. *L. septenarius* usually is found above the first occurrence of *M. furcatus* (PERCH-NIELSEN, 1979) but was here found without it. We must thus conclude that it here occurs earlyer than *M. furcatus* or that the latter is not a very reliable marker, either.

Fossiliferous exposures of the Awgu Formation were also sampled at about 34 km from Calabar, on the Calabar-Itu road. In this roadcut are exposed about 8 m of dark grey, calcareous, nodular mudstone with fairly abundant planktic micro-

fossils (fig. 4). Here the association of *Marginotruncana renzi*, *Hedbergella hoelzli*, and *H. crassa* suggests a Turonian to Coniacian age for this part of the Awgu Formation. Although no good coccolith markers were found, the presence of *Lithastrinus moratus* together with *L. septenarius* in one of the samples (KC I, 18; fig. 4), indicate

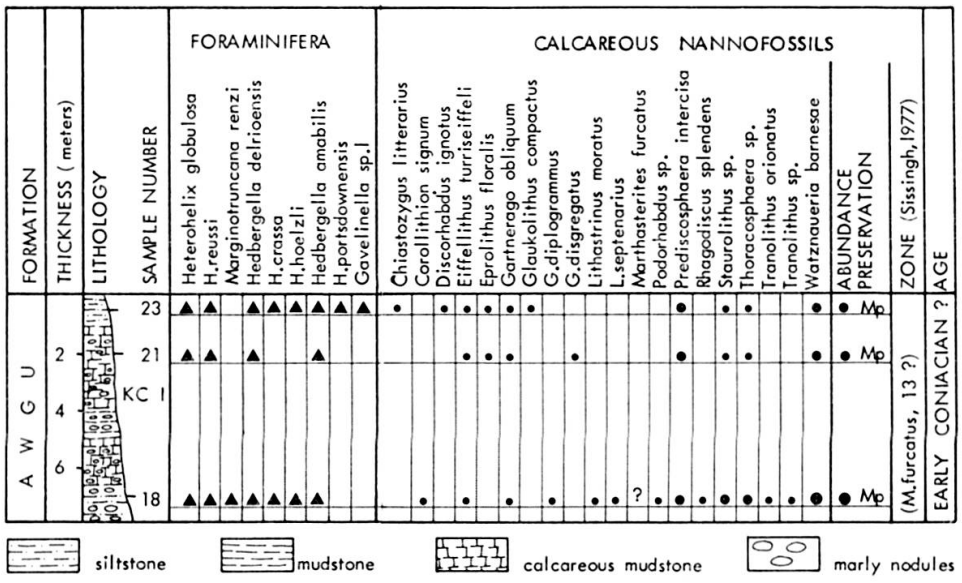

FIG. 4. — Distribution of planktic microfossils in the Awgu Formation exposed in a roadcut 34 km to Calabar on the Calabar-Itu road.

that this sample represents SISSINGH's 13, the *Marthasterites furcatus* Zone, since they only occur together in this zone. Typical specimens of *M. furcatus* with furcated arms were not found, but several triangular bodies found in sample KC I 18 could represent overgrown specimens of *M. furcatus*. But here, too, no *E. eximius* was found, and the age assignement is questionable.

AMEKE FORMATION

Commonly mis-spelt as "Ameki", the Ameke Formation is a sequence of greenish-grey sandy mudstone and clayey sandstone with concretionary calcareous nodules and occasionally thin limestone bands. The total thickness of the Ameke Formation is about 1550 m (DESSAUVAGIE, 1975), but only the top 6 m was sampled along the Enugu-Port Harcourt expressway, about 7 km to Umuahia (fig. 5). This profile contains abundant foraminifera, coccoliths, ostracodes and radiolarians.

The Ameke Formation was broadly subdivided into an Early Eocene *Globorotalia formosa* Zone, a late Early and Middle Eocene *Cassigerinelloita amekensis* Zone, and a Late Eocene *Chiloguembelina martini-cubensis* Zone (STOLK, 1963). The exposure of the Ameke Formation near Umuahia belongs to the *Globorotalia for-*

mosa formosa Zone on account of the co-occurrence of *Acarinina pseudotopilensis* of Late Paleocene — Early Eocene range (STAINFORTH et al. 1975), and *Acarinina pentacamerata* which ranges from the Early Eocene *G. formosa formosa* Zone throughout the Early Eocene (LUTERBACHER, 1975), although STAINFORTH et al (1975) extended the range of *A. pentacamerata* into Middle Eocene.

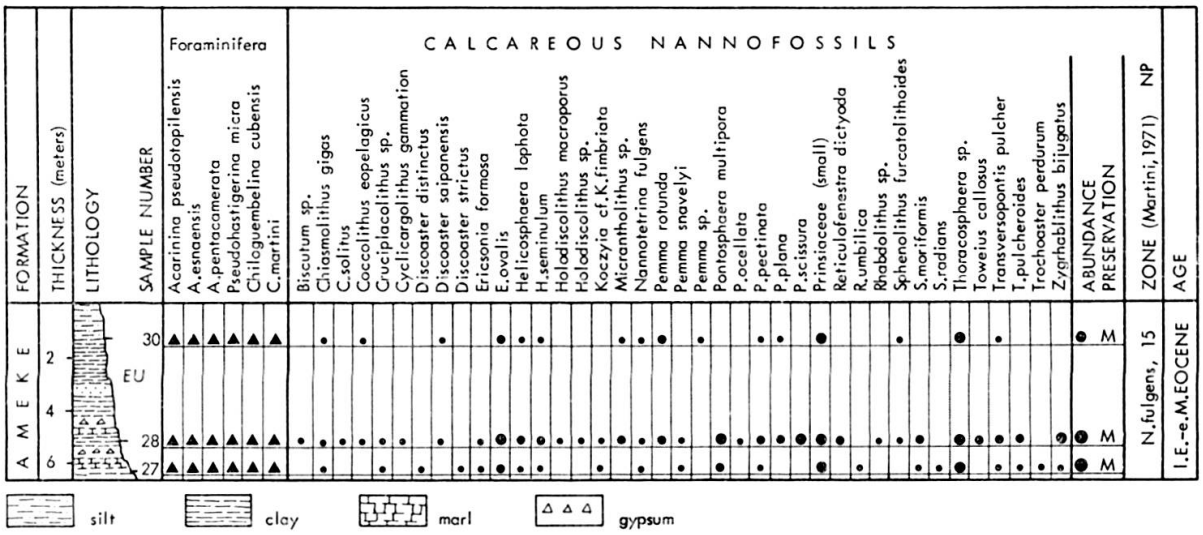

FIG. 5. — Distribution of planktic microfossils in the Ameke Formation exposed in a roadcut 7 km before Umuahia on the Enugu-Port Harcourt expressway.

Calcareous nannofossils

3 samples from the Ameke Formation were studied and contain quite rich calcareous nannofossil assemblages with about 40 species, mainly belonging to the genera *Pontosphaera*, *Transversopontis*, *Helicosphaera*, *Ericsonia* and *Pemma* besides the small Prinsiaceae and some holococcoliths (*Trochoaster*, *Holodiscolithus* and *Zygrhablithus*) and rare to very rare other forms, including the Middle Eocene marker species *Nannotetrina fulgens* and *Chiasmolithus gigas*, which were found in all 3 samples. Discoasters are very rare and include only *Discoaster saipanensis*, *D. strictus* and *D. distinctus* and only one specimen of *Reticulofenestra umbilica* with a diameter of about 11 microns, was found. Also *Chiasmolithus* is very rare. The assemblage is typical of relatively shallow shelf seas (abundance of Pontosphaeraceae and Braarudosphaeraceae, scarcity of *Discoaster* despite the low latitude, where discoasters usually are common).

The presence of *C. gigas* allows the assignement of these assemblages to CP 13b, the *C. gigas* Subzone of OKADA & BUKRY, 1980, the presence of *N. fulgens* together with *Chiasmolithus solitus* to the *N. fulgens* Zone, NP 15, of MARTINI, 1971. NP 15 is usually regarded as belonging to the Middle Eocene, but was shown by BERGGREN, 1972, to extend down into the Lower Eocene.

BIBLIOGRAPHY

ARUA, I. and V. R. RAO (1978). Ammonite evidence for the age of Nkalagu limestone, Anambra State, Nigeria. *Jour. Min. Geol. Nigeria*, Vol. 15, pp. 47-48.

BERGGREN, W. A. (1972). A Cenozoic time-scale — some implications for regional geology and paleobiogeography. Lethaia, Vol. 5, No. 2, pp. 195-215.

BOLLI, H. M. (1959). Planktonic foraminifera from the Cretaceous of Trinidad, B. W. I., *Bull. Am. Paleontology*, Vol. 39/179, pp. 257-277.

CARTER, J. D., W. BARBER, E. A. TAIT, and G. P. JONES (1963). The geology of parts of Adamawa, Bauchi and Bornu Provinces in northeastern Nigeria. *Geol. Surv. Nigeria Bull.*, No. 30, 108 pp.

DE KLASZ, I. and D. RERAT (1963). The stratigraphic range of the foraminiferal genus *Gabonella* in the Upper Cretaceous of Gabon (Equatorial Africa). *Micropaleontology*, Vol. 9, pp. 325-326.

DESSAUVAGIE, T. F. J. (1975). Explanatory note to the geological map of Nigeria. *Jour. Min. Geol. Nigeria*, Vol. 9, pp. 1-28.

EICHER, D. K. and P. WORSTELL (1970). *Lunatriella*, a Cretaceous heterohelicid foraminifer from the western interior of the United States. *Micropaleontology*, Vol. 16, pp. 117-121.

FAYOSE, E. A. and I. DE KLASZ (1976). Microfossils of the Eze-Aku Formation (Turonian) of Nkalagu quarry, Eastern Nigeria. *Jour. Min. Geol. Nigeria*, Vol. 13, pp. 51-61.

LUTERBACHER, H. (1975). Planktonic foraminifera of the Paleocene and Early Eocene, Possagno section. *Schweizerische Palaontologische Abhandlungen*, Vol. 97, pp. 57-67.

MARTINI, E. (1971). Standard Tertiary and Quaternary calcareous nannoplankton zonation. Proc. 2nd Conf. Planktonic Microfossils, 2, pp. 739-786.

MURAT, R. C. (1972). Stratigraphy and paleogeography of the Cretaceous and lower Tertiary in southern Nigeria. *African Geol.*, Ibadan, pp. 251-266.

NEUFVILLE, E. M. H. (1973). Upper Cretaceous-Paleocene ostracodes from the South Atlantic. *Pub. Paleont. Inst. Univ. Uppsala*, Special Vol. 1, 205 pp.

OKADA, H. and D. BUKRY (1980). Supplementary modification and introduction of code numbers to the low-latitude coccolith biostratigraphic zonation (BUKRY, 1973; 1975). Marine Micropal., vol. 5, pp. 321-325.

PERCH-NIELSEN, K. (1979). Calcareous nannofossils from the Cretaceous between the North Sea and the Mediterranean. IUGS Series A, No. 6, pp. 223-272.

PESSAGNO, E. A. JR. (1967). Upper Cretaceous planktonic foraminifera from the western Gulf Coastal Plain. *Paleontographica Americana*, Vol. 5/37, pp. 245-445.

PETTERS, S. W. (1977). Upper Creaceous planktonic foraminifera from the subsurface of the Atlantic Coastal Plain of New Jersey. *J. Foram. Research*, Vol. 7, pp. 167-187.

—— (1978). Mid-Cretaceous paleonvironments and biostratigraphy of the Benue Trough, Nigeria. *Geol. Soc. Amer. Bull.*, Vol. 89, pp. 151-154.

—— (1980). Biostratigraphy of Upper Cretaceous foraminifera of the Benue Trough, Nigeria. *J. Foram. Research*, Vol. 10/3.

REYMENT, R. A. (1965). *Aspects of the geology of Nigeria.* Ibadan, 145 pp.

—— (1980). Paleo-oceanology and paleobiogeography of the Cretaceous South Atlantic Ocean. *Oceanologica Acta*, Vol. 3, pp. 127-133.

SISSINGH, W. (1977). Biostratigraphy of Cretaceous calcareous nannoplankton. *Geologie en Mijnbouw*, Vol. 51, pp. 37-65.

STAINFORTH, R. M., J. L. LAMB, H. LUTERBACHER, J. H. BEARD and R. M. JEFFORDS (1975). Cenozoic planktonic zonation and characteristics of index forms. *The Univ. Kansas Paleont. Contrib.* Art. 62, 425 pp.

STOLK, J. (1963). Contribution à l'étude des corrélations microfauniques du Tertiaire inférieur de la Nigeria méridionale. *Mem. Bur. Rech. Geol. Min.*, N° 32, pp. 247-274.

VAN HINTE, J. E. (1976). A Cretaceous time scale. *Am. Assoc.* Petrol. Geol. Bull., Vol. 60, pp. 498-516.