Diatom Distribution and Palynofacies Analysis in Bonny Coastal Swamp of Niger Delta

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ABSTRACT:

Twelve ditch cutting samples were collected on the sedimentary shale deposits of some part of Bonny area, in the Niger Delta region, where palynological analysis was performed to infer the history of the palynofacies and paleoenvironmental changes in the study area. The results revealed diatoms species among benthic and planktonic life forms. Correspondence analysis applied to relative abundance of diatoms and associated with sedimentary deposit. The age of the well can be determined with the presence of some diagnostic palynomorph which include Aspitianodulifer, Thalassiosira ferelinate, Thalassiosira oestriupii, Chactoceros, Nitzschi apaerenheildii and Actinocyculu sundulotus, which is a diagnostic form of Miocene to Pliocene that indicated more energy than in present days, originating a coastal swamp. And their paleoenvionments is coastal swamp sedimentary environment, grey shale was observed only in the core showed the prevalence of planktonic diatoms, providing evidence of a deeper and calmer environment, located in a probably protected area, with intense sedimentation of shale particles with abundant plant remains, colonized by mangrove forest and alluvial palm forest. The lower organic-shale within three stations showed more agitated and erosive sedimentary conditions, however, with less energy indicated by high abundance of Thalassioira lineate Jouse. The sedimentary environment allowed colonization by which persists on the coastal to swamp.

KEY WORDS: *Palynomorph, Palynofacies, Niger Delta*

INTRODUCTION

Diatoms algae abundant in most aquatic habitat are useful proxies for the paleoenvironment analysis of three Stations on the Bonny Area. Acutely sensitive to changes in pH, salinity, temperature, hydrodynamic conditions, and nutrient concentrations, marine diatoms can be identified by their distinct assemblages and frustule shape. The ubiquitous distribution diatoms, their high species diversity, and their siliceous frustule all enable the diatoms to function as sound environmental indicators. A study of the modern diatom distribution in subsurface sediments, in the intertidal zone of Bonny Beach, showed that the sand/clay ratio was influenced by present-day hydrodynamic processes, probably determining the local prevalence of planktonic diatom assemblages associated with muddy to mud-sandy sediments and benthic/epipsammic diatom assemblages associated with sandy samples (Ribeiro *et al*., 2008). These results allowed us to evaluate the whole of diatoms on estuarine dynamics as a biological indicator for erosion/accretion processes (Ribeiro *et al*., 2008). Thus, the aim of the paper was to determine palynofacies, depositional environment and diatom distribution occurred at Bonny area,

GEOLOGY OF NIGER DELTA

The Niger Delta is situated on the Gulf of Guinea on the west coast of Central Africa. During the tertiary it built out into the Atlantic Ocean at the mouth of the Niger-Benue River System, and catchments area span about a million square kilometres of predominantly savannah-covered lowland (Merki, 1972). The Delta is one of the world's oil provenances with the sub-aerial portion covering about 75 000 km^2 and extending more than 300 km from apex to mouth (Short et al, 1967). The regressive wedge of clastic sediments which it comprises is thought to reach a maximum thickness of 12 km (Murat, 1972). Accumulation of marine sediments in the basin probably commenced in Albian time, after the opening of the South Atlantic Ocean between Africa and South America Continent. True delta development, however started only in the Late Paleocene/ Eocene, when sediments began to build up beyond troughs between basement horst blocks at the northern flank of the present delta area (Ogbe, 1982). Since then, a delta plain prograded southward on to oceanic crust gradually assuming a convex to the sea morphology (Doust and Omatsola, 1990).

Throughout the geological history of the delta, its structure and stratigraphy have been controlled by the interplay between rate of sediments supply and subsidence (Murat, 1972). Important influences on sedimentation rate have been ecstatic sea level changes and climatic variations, initial basement morphology and differential sediment loading on unstable shale (Whiteman, 1982). The delta sequence is extensively affected by synsedimentary and post sedimentary normal faults, the most important of which can be traced over considerable distance along strike (Merki, 1972).

STRATIGRAPHY OF THE NIGER DELTA

The tertiary lithostratigraphic sequence of the Niger Delta consists in ascending order Akata, Agbada and Benin Formations which make up an overall massive clastic sequence of about 30000-39000ft (9000- 12000m) thick (Evamy et al, 1978).

AKATA FORMATION

The basal major time-transgressive lithological unit of the Niger Delta complex is the Akata Formation. It is composed mainly of marine shales but contains sandy and silty beds, which are thought to have been laid down as turbidites and continental slope channel fills above (Merki, 1972). The Akata Formation is characterized by a uniform shale development as evident in gamma ray and spontaneous potential logs (Merki, 1972). These pro-delta shales are grey to dark grey, medium-hard or soft at some places and sandy or silty. The shales are under-compacted and may contain lenses of abnormally high pressured siltstone or fine-grained sandstone (Merki, 1972). Furthermore, the Akata Formation is thought to be the main source for Niger Delta complex oil and gas. The Akata Formation may be continuous with the outcrops of the Imo Shale, but continuity between the two type sections which are of very different ages is not yet proved. The known age of the Akata Formation ranges from Eocene to Recent (Murat, 1972).

AGBADA FORMATION

The Agbada Formation is believed to be the hydrocarbon prospective sequence in the Niger Delta. It is represented by alteration of sands, silt and clays in various proportions and thicknesses, representing cyclic sequences of off lap units (Murat, 1972). These paralic clastics are the truly deltaic portion of the sequence and were deposited in a number of delta-front, deltatopset and fluvio-deltaic environments (Whiteman, 1982).The alternation of fine and coarse clastics provide multiple reservoir-seal couplets (Murat, 1972). As with the marine shale, the paralic sequence is present in all depobelts, and ranges in ages from Eocene to Pleistocene (Merki, 1972). Most exploration wells in the Niger Delta have bottomed in this lithofacies, which reaches a maximum thickness of more than 3000m (Doust and Omatsola, 1990).

BENIN FORMATION

The Benin Formation occurs throughout the whole Niger Delta from Benin-Onitsha in the north to beyond the present coastline. It constitutes the shallowest part of the sequence and is composed almost entirely of non-marine sand predominantly massive, highly porous fresh water-bearing sandstones with local thin shale interbed which are considered, braided-stream origin (Whiteman, 1982). The sand and sandstone of the Benin Formation are coarse grained, commonly very granular and pebbly to very fine grained. They were deposited in alluvial or upper coastal plain environments following a southward shift of deltaic deposition into a new depobelt (Whiteman, 1982).

METHODOLOGY

Twelve core samples samples were used for both palynological and sedimentological studies. Lithologic description of the samples was done by examining them under the binocular microscope by noting the textural characteristics such as colour, grain size, shape (roundness), sorting, effect of ferruginization, and fossil content in terms of plant remains. Palynological slides were prepared by subjecting the samples to initial digestion by adding dilute hydrochloric acid into them in order to remove calcium carbonate (CaCO3) that might be present. This is followed by hydrofluoric acid (HF) digestion overnight for proper liberation of the organic macerals present in the samples. Recovered macerals from sieving with nylon sheet of 10µm in order to remove clay particles present is followed by oxidation, heavy liquid separation and mounting of the residue on glass slides with D. P. X. mountant, ready for palynological analysis. The method of preparation conforms to international standard. Taxa counts were made to determine the relative frequency of each species in each sample, after which the diagnostic species photographs were taken using Koolpix camera 6000 model.

RESULTS AND DISCUSSION

Sedimentology

The litho-description follows the standard method of describing samples as described in the methodology. Four informal sedimentary units were deduced from the analysis of the ditch cutting from Bonny area. The sandy shale unit is dark grey in colour, blocky to fissile in nature; fairly ferruginized The wet-sieve analysis that was carried out on the (12) ditch cutting samples produced a grain size analysis Table

Table1: Showing the grain size analysis.

Depth	Weight of filter paper(g)	Weight of sample + filter paper(g)	Weight of sample (g)
0-2	1.0	16.7	15.7
2-4	1.0	16.2	15.2
4-6	1.0	18.1	17.1
6-8	1.0	17.6	16.6
8-10	1.0	16.2	15.2

10-12	1.0	19.9	18.9
12-14	1.0	28.5	27.5
14-16	1.0	18.3	17.3
16-18	1.0	28.6	27.6
18-20	1.0	25.3	24.3
20-22	1.0	16.3	15.3
22-24	1.0	17.0	16.0

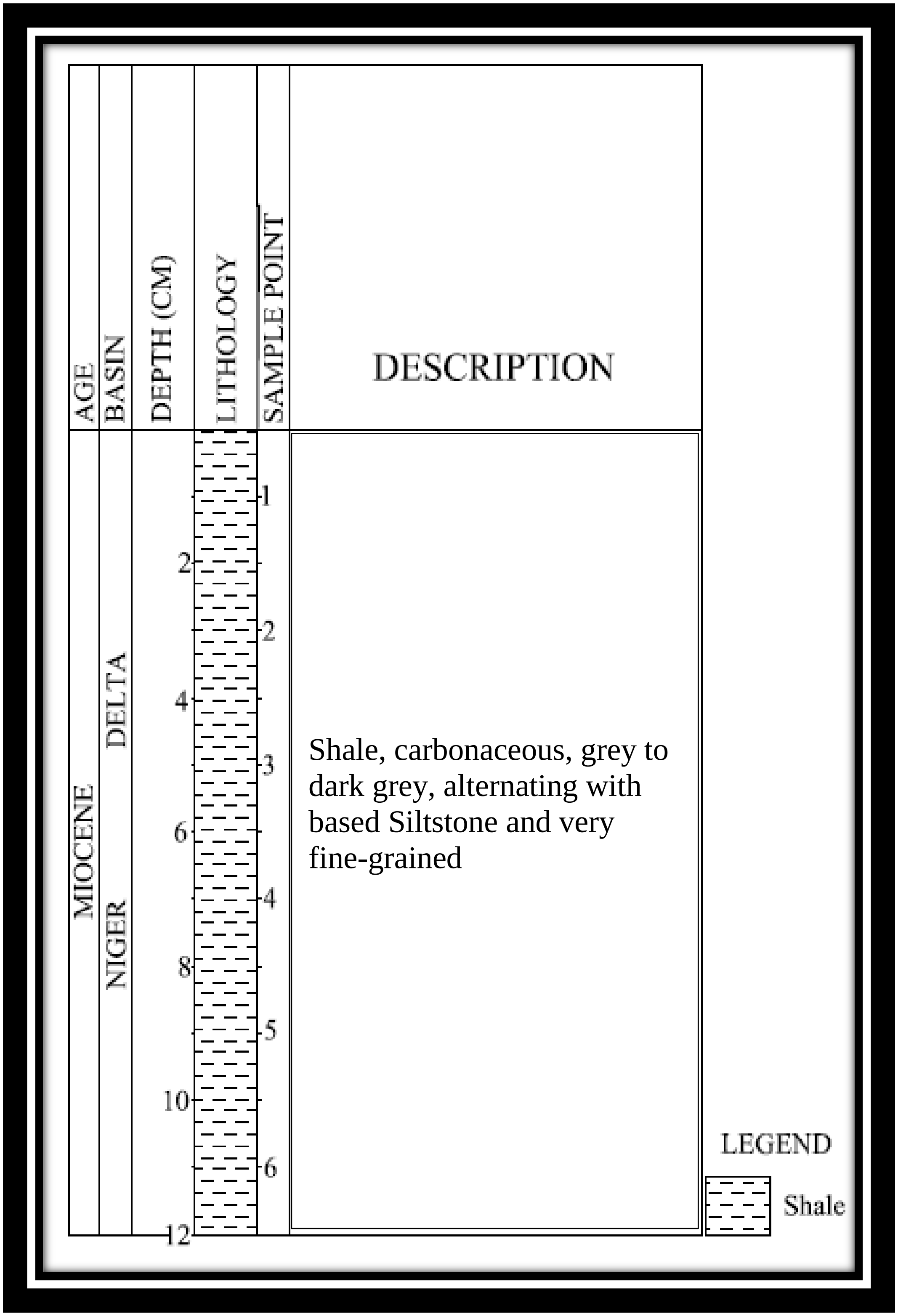


Figure1: Lithology Description of the Study Area.

TABLE 2: SHOWING THE PALYNOFACIE ANALYSIS OF THE STUDY AREA

Depth (cm)	Sample point	Equidimensional black %	Equidimensional brown %	Bladed shape %	Cellular debris %	Granular %	Micro fossils %
0							
	1	50	30	10	-	-	10
2							
	2	20	50	10	10	-	10
4							
	3	20	40	20	5	-	15
6							
	4	30	50	10	-	-	10
8							
	5	20	60	10	5	-	5
10							
	6	40	50	-	5	-	5
12							

PALYNOFACIE INTERPRETATION FOR THE STUDY AREA.

From the trend of the Palynofacie analysis that was carried out, it is obvious that sediment from marine environment of the younger sediments yielded the data from Figure 2, 3 and 4. The analysis shows the percentages distribution of palynofacie.

From sample 1-3 with depth 0-6cm marks an increase in equipdimensional brown debris with a decrease in equipdimensional black abundant in and also a little deposit of bladed black, the presence of cellular debris and micro fossils found within these depths are on a small scale which is associated with organic matter helped in the paleoenvironmental interpretation of the study area. The presence of diatom within these depth include *Thalassiosira oestriupii*, *Thalassiosira ferelinate*, *Aspitia nodulifer*, *Thalassiosira lineate (jouse)*, *Coscinoiscus radiates*, *Actinoptychus senarius*, *Thalassiosira lentiginosa*, and *Pseudotriceratium cinanomeum*, at sample point 2 shows the presence of *Glaeicheniidites senonicus*, *Cingulatisporites sp*, *Pinupollenites taedaeformis*, and *Pachylermites diedenxii*. The presence of fungal probably further confirms a swamp depositional environment. The dominance of diatom, pollen and spore, in addition to the presence of abundant plant debris, probably indicate a coastal swamp environment.

In sample 4-6, with the depth of 8-12cm mark a definite increase in equipdimensional brown debris with a little decrease in equipdimensional black and a deposit of 20% bladed black the presence of cellular debris and micro fossils found within these depths are on a small but are rich in diatom which include *Aspitia nodulifer*, *Thalassiosira oestriupii*, *Thalassiosira lentiginosa*, *Thalassiosira ferelinate*, *Thalassiosira lineate (jouse)*, and *Lyrella lyra*, which is associated with pollen and spore *Glaeicheniidites senonicus*, *Cycadopites sp*, *Diitoidospira sp* and. Mostly they are found in a marine environment and could be a coastal swamp.

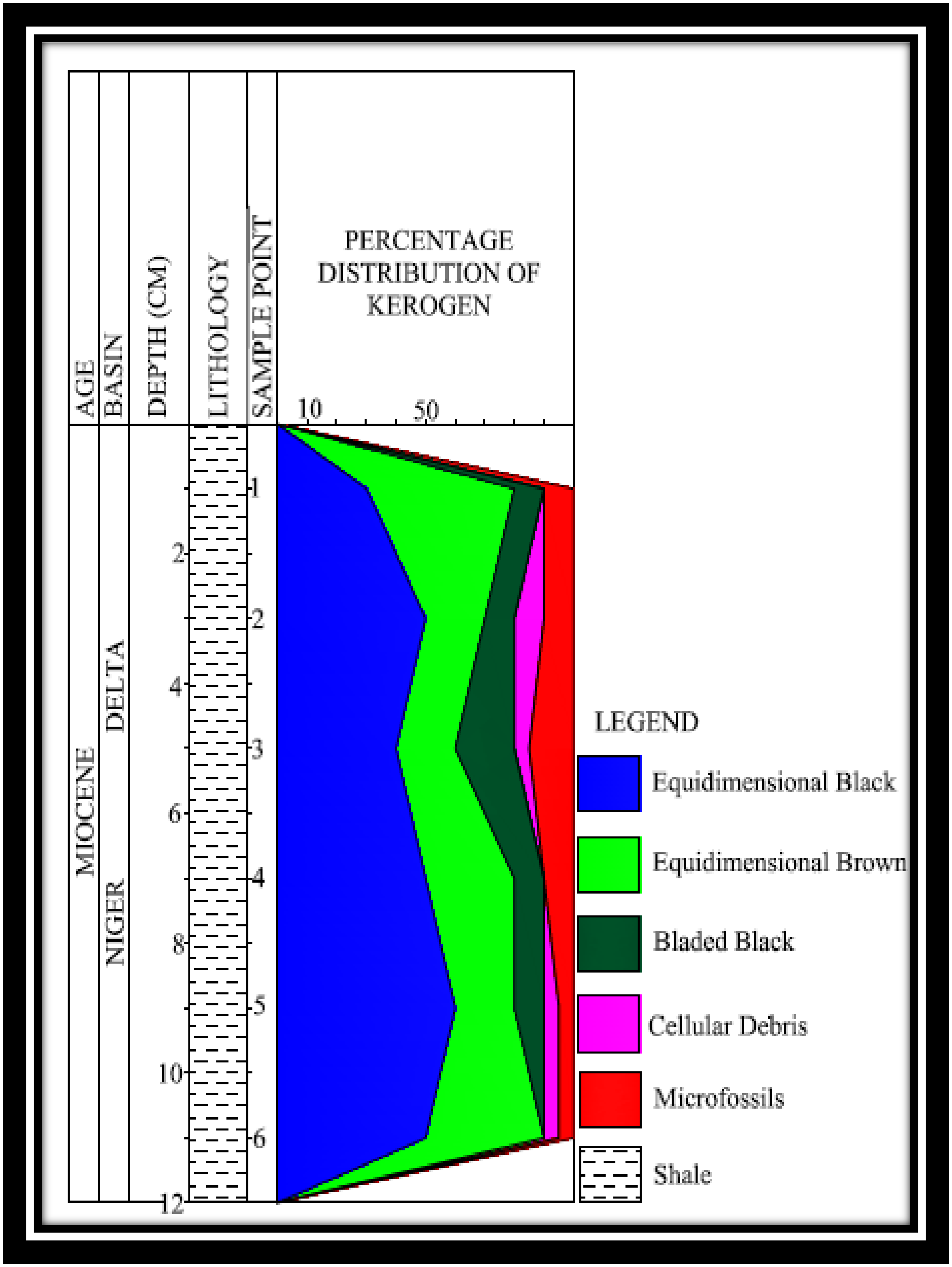


Figure 2: Percentage Distributions of Kerogen in the Study Area.

DISCUSSIONS

The prevailing diatom in all three Stations was *Aspitia nodulifer*, *Thalassiosira oestriupii*, *Thalassiosira lentiginosa*, *Thalassiosira ferelinate*, *Thalassiosira lineate (jouse)*, *Lyrella lyra*, *Actinoptychus senanius* and *Pseudotriceratuim cinanomeum*, was found in Bonny ditch cutting within the study area. The chart are quantities of diatom species at similar depths in the ditch cutting within the stations. Although pennate diatoms dominate the observed specimens, both pennate and centric diatoms were found in some parts of Bonny samples, as can be seen by the presence of both *Thalassiosira lineate Jouse* and *Pseudotriceratium cinanomeium*. The small size of the diatoms can be problematic as their light weight may allow for air transport. Also, as planktonic diatoms are constructed to remain in suspension, they can easily be transported laterally by both bottom currents and surface currents. Broken diatoms may also indicate that displacement has taken place in which the total diatom abundance per gram of sediment and diatom distribution charts was used. *Thalassiosira lineate Jouse* suggests seasonal turnover or turbulence, in which the diatoms could be moved from the benthic to the photic zone (Meyer, 2002). *Thalassiosira lineate Jouse* further indicates warm temperatures and a relatively high organic content in the water. The high concentration of *Thalassiosira lineate Jouse* and other diatom species within the area suggest similar environmental conditions in the Bonny coastal swamp area over the time represented by the ditch cutting in this study. Particular differences are representative of seasonal fluctuations in temperature, salinity, and nutrient concentration.

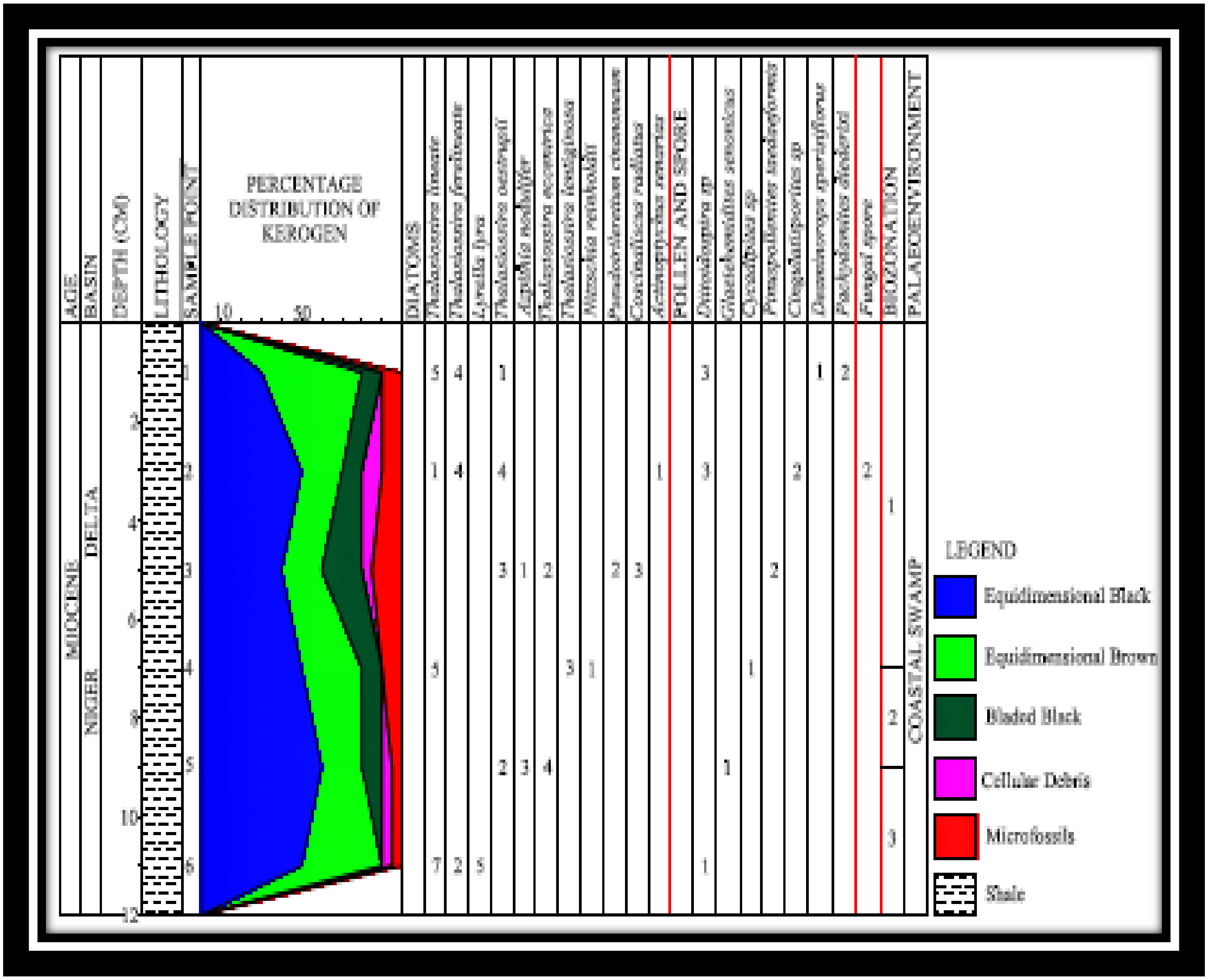


Figure 3: Percentage Distributions of Kerogen and Diatom Distribution of the Study Area.

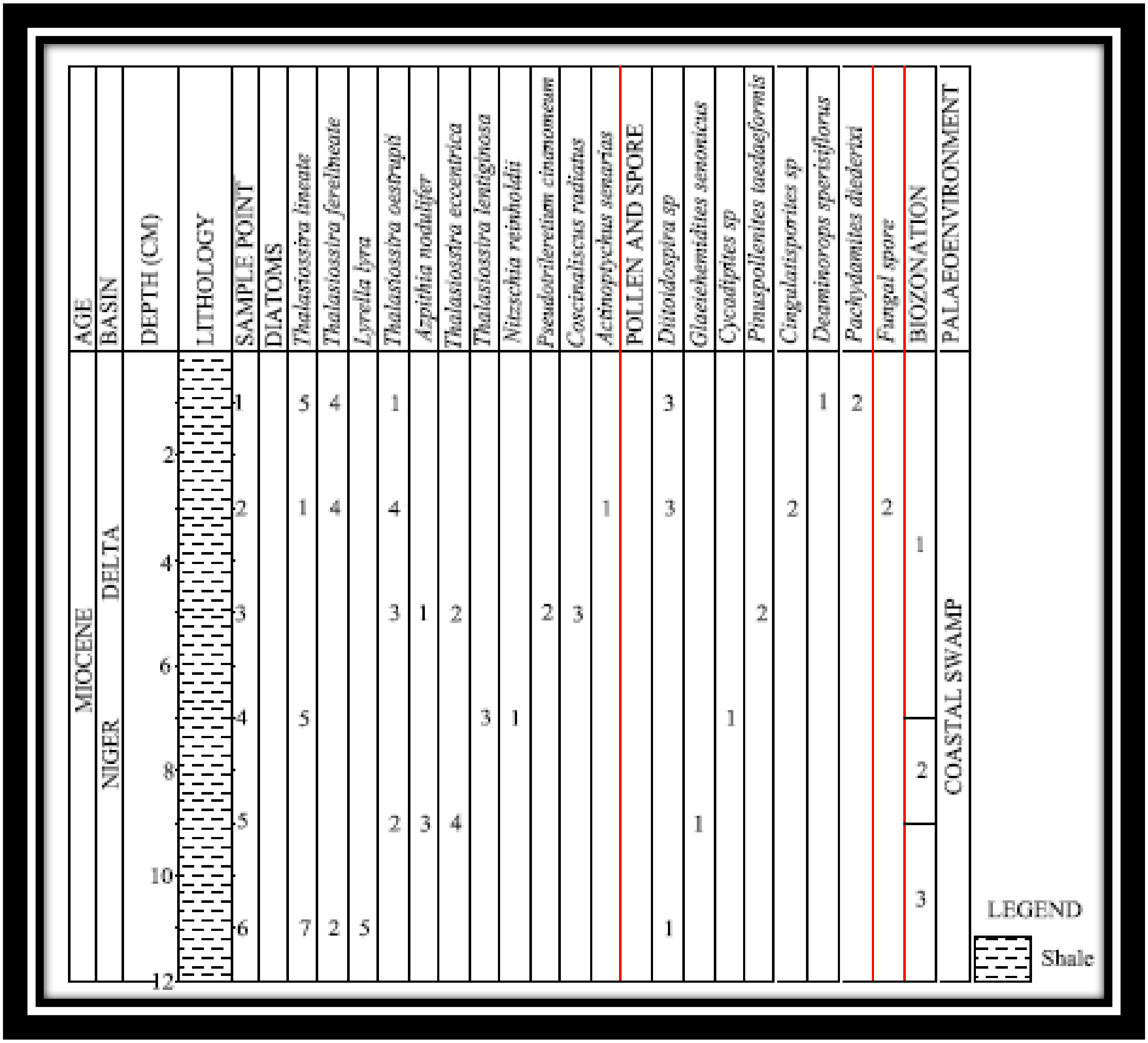
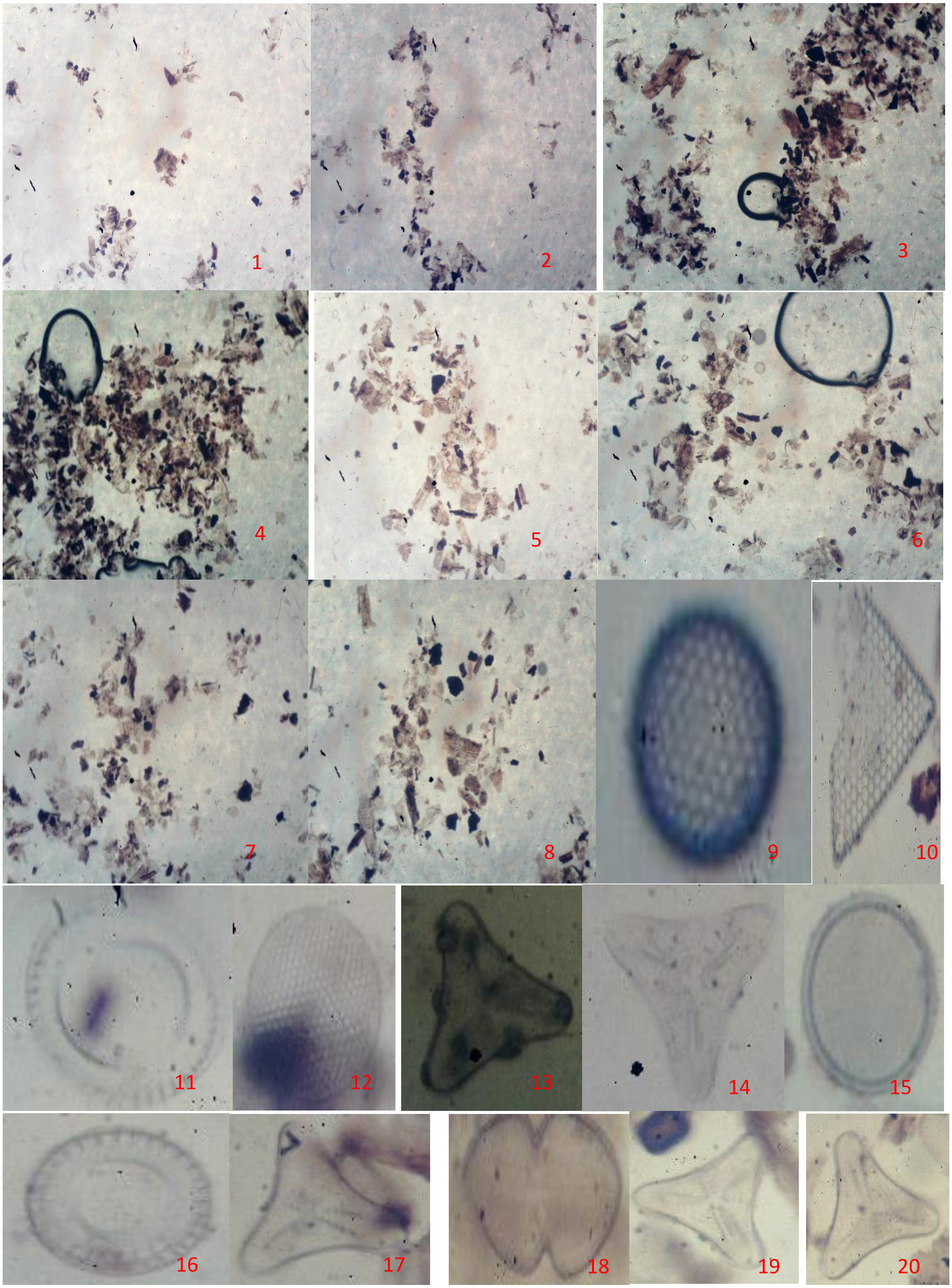
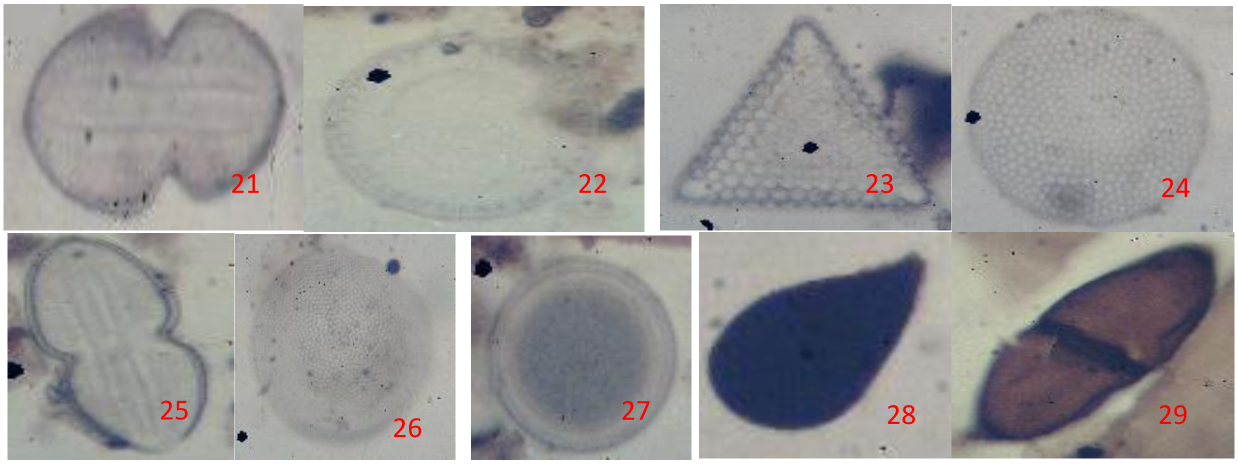


Figure 4: Range chart Distribution of Diatom, Pollen/Spore and Fungal Spore of the Study Area.

PLATES





EXPLANTION TO PLATE

Fig 1-8 kerogen retrieved from study area Organic matter consists of 38%equidimensional black debris, 50% equidimensional brown debris, 10% bladed shape debris and 5% microfossils

Fig 11 and 16 Coscinodiscus radiates.

Fig 13,17,19,20 Glacichenniidites senonicus.

Fig 10 and 23 Pseudotriceratum cinanomeum.

Fig 9, 12 and 24 Thalassiosira oestrupii.

Fig 14, 16 and 22 Azpitia nodulifer.

Fig 18, 21 and 25 Pinuspollenites tacdeformis.

Fig 15, 26 and 27 Lyrella lyra.

Fig 28 and 29 Fungal spore.

CONCLUSION

With strong implications on distribution and relative abundance of both planktonic and benthic diatoms and on vertical and lateral variations of sedimentary environment. The modern diatom distribution and its association with textural sediments observed in the intertidal zone at part of Bonny area showed an important role in the paleoenvironmental reconstruction during the last deposition. These new environmental conditions contributed to the retention of organic shale sediments and favored the dominance of planktonic diatom species, indicated by the good preservation of these organisms. The age of the well can be determined with the presence of some diagnostic palynomorph which include *Aspitia nodulifer*, *Thalassiosira ferelinate* and *Thalassiosira oestriupii*, *punctate* which is a diagnostic form of Miocene to Pliocene.

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