

Distribution of palynomorphs from mangrove swamps in the Eagle Island section of the New Calabar River in the Niger Delta

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ABSTRACT: Palynological results have been employed in interpreting the distribution of palynomorphs from mangrove swamps in the Eagle Island section of the New Calabar River, recent sediments from fifteen locations in the area were palynologically examined. The results record about forty per cent in abundance of palynomorphs, it shows that the pollen from mangroves was believed to have substantially increased to very high grains, and probably transported landward by wind with the presence of charred Poaceae cuticles and *Podocarpus milanjanus* which has accounted for the higher records of Poaceae in the study area. The abundant plants represented in the sediment source areas as revealed by the palynomorphs recovered are Poaceae, *Elaeis guineensis*, *Acrostichum aureum*, *Pteris* spp., *Nephrolepis undulata*, *Cyclosorus afar* and *Verrucatosporites* spp. Pollen of *Rhizophora* spp. and freshwater forest trees that are abundant in sediments have been reduced greatly and replaced by Poaceae and *Elaeis guineensis* pollen due to anthropogenic activities. Proximity to shore determines the abundance of pollen and spores, fungal spores *Concentricytes*, *Protoperidinium* spp. and other dinoflagellates with the lowest temperature and high salinity. Microforaminiferal wall linings were however recovered mostly in the proximal area, recovered diatoms show useful ecological trends. These results further confirm the usefulness of these palynomorphs and diatoms for paleoenvironmental and paleovegetational reconstruction. The degradation of ecosystems has undergone anthropological activities within the study area.

Keywords: Palynomorphs, Poaceae, pollen and spores, reconstruction, spatial distribution.

INTRODUCTION

Processes of microfossil taxonomy are the basis for palynological studies in the Quaternary Period. A stable depositional environment is required to ensure that changes in pollen assemblages can be attributed to vegetation changes rather than depositional episodes (Jackson, 1994). Studies of lake surface sediments have shown advantages in verifying the effects on the transport (aerial, fluvial, etc.) of pollen grains and spores. They also explain the pollen and spore patterns of deposition in a receiving basin, as well as details of selective processes for diagenesis (Chmura *et al.* 1999). The deposition of pollen grains from the air is uniform over the lake surface, but the difference in sinking speed depends on the size or

density of the pollen grain. Wind-driven currents are known to affect the distribution of planktons (Davis, 1968; Davis and Brubaker, 1973) and Bradley (1965) pointed out that the settling velocity of many particles, such as diatoms are too low to reach the bottom of deep lakes in the same year of floatation. Eventually, they may be hydraulically sorted (Heusser, 1978) in the same manner as particles of fine silt and clay. The resuspension of pollen grains and spores from the bottom and the overlying, semifluid sediment stratum is a continuous process. It is probably more intensive in shallow waters than in deep ones and consequently occurs less in the central area of a water basin than near the shores. The rate of resuspension

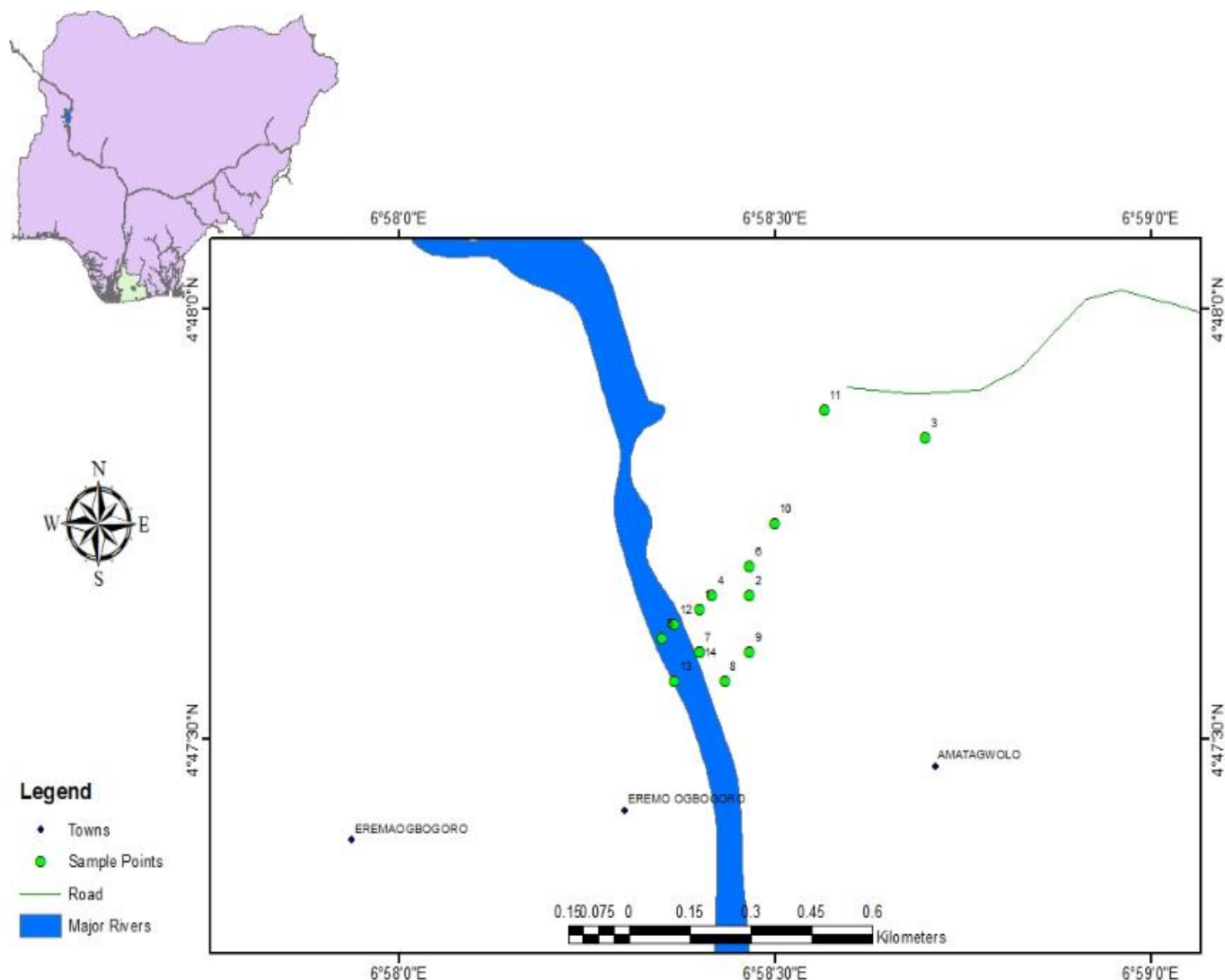


Figure 1. Location Map of the study area.

varies also with the seasons of the year (Praglowksi, 1977). It is possible to verify the presence of reworked grains through the aspect of the exine preservation, and consequently, the redeposition of sediments (Delcourt and Delcourt 1980; Moore *et al.* 1991). The aim of this study is to infer on the deposition of palynomorphs in the Recent sediment from mangrove swamps in the Eagle Island section of the New Calabar River and the objective is to assess the sedimentation for palaeoecological of the study area and correlate with the surrounding vegetation in the study area.

Brief geology of the study area

The Eagle Island section of the New Calabar River and its tributaries are all located in Rivers State (Figure 1). It is a low-lying deltaic river which rises at approximately latitude

5°10'N and longitudes 6°50'E near Elele-Alimini and flows Southward for roughly 150 km before its discharge into the Atlantic Ocean at about latitudes 4°20'N and longitudes 7°00'E. It occupies a low relief region, ranging from 0-50 m above sea level at the low zone, to 50-100 above sea level at its source. The soil of the river basin consists of clays, silt and sand, with high organic matter. The study area is part of the Niger Delta Basin and the development of the delta has been dependent on the balance between the rate of sedimentation and the rate of subsidence. This balance and the resulting sedimentary patterns appear to have been influenced by the structural configuration and tectonics of the basement. From the Eocene to the present, the delta has prograded southwestwards, forming depobelts that represent the most active portions of the delta at each stage of its development (Doust and Omatsola, 1990). The Niger- Delta Basin is located on the West African continental margin where the east-trending

equatorial coast turns south towards the Equator. It underlies the coastal plain, the continental shelf and slope of Nigeria and western Cameroon, and the northern territorial waters of Equatorial Guinea, West of Bioko Island. Its southern margin is marked by seafloor escarpments, which lie over the oceanic crust. The Niger Delta basin covers approximately 211,000 km² and developed southwestwards out of the Anambra Basin and the Benue Trough.

The Niger Delta basin is located within the periocenic section of the Abakaliki-Benue suture zone of the much larger southern Nigerian basin. On the west it is separated from the Dahomey (or Benin) basin by the Okitipupa basement high, and on the east is bounded by the Cameroon volcanic line. The Benin flank, which is the subsurface continuation of the West African Shield, marks the North-Western rim of the basin. To the north of the Cenozoic basin lie the Senonian Abakaliki Uplift and the Post-Abakaliki Anambra Basin (Murat, 1972).

MATERIALS AND METHODS

A total of 15 ditch-cutting samples from the Eagle Island section of the New Calabar River in the Niger Delta Basin were collected at intervals for this study. The samples were stored in sample bags with depth labels to avoid contamination. They were firstly washed with distilled water to remove the drilling mud stains and this was followed by sample administration. Detailed properties of rock samples including grain size, sorting, shape and mineral composition were observed and documented. Exactly 10 g of each sample was transferred to the labelled plastic beaker. The samples were soaked with an excess of 10% hydrochloric acid (HCl) to remove any carbonate that may be present in the samples and thereafter completely neutralized with distilled water prior to treatment with hydrofluoric acid. Following this, 40% HF was added to samples and left for 24 hours to ensure complete digestion of silicate minerals and thereafter completed with distilled water. Fluoro-silicate compound result from the last reaction was removed by treating the sample with 10% HCl, followed by complete neutralization with distilled water. Samples were not subjected to oxidation to avoid selective destruction of palynomorphs. The decanted samples were sieved using a 200 µm mesh filter to separate the residual rock particles and mega fossils from the finer disaggregated material. The filtrate (i.e. finer disaggregated material) was thoroughly washed with distilled water using the 10 µm mesh nylon sieve. The palynomorphs were separated from the residue using Zinc Bromide gel (ZnBr₂) and centrifugation. The ZnBr₂ was completely washed off by the addition of distilled water and centrifugation. A pipette was used to place one or two drops of the residue at the centre of each slide and allowed it to dry under ultraviolet light. A single drop of warm petropoxy resin was placed on the cover slip and then placed over the residue-bearing slide. The slide was

allowed to stay for about 10 minutes to ensure that the slide is firmly glued to the cover slip. The prepared palynological slides were scanned under the National Optical Microscope. Microscopy involved a preliminary examination of the prepared slides to identify flora followed by a quantitative listing of the palynomorphs. Where possible, a total of 150 palynomorphs were counted per sample during microscopy. Identification of fossil flora forms was aided by the comparison of morphological features of specimens with reference illustrations from published literature (Germeraad *et al.*, 1968).

RESULTS AND DISCUSSIONS

The results have been separated into lithology, percentage distribution of palynomorphs, paleoenvironment zones, paleoecology and pollen assemblage.

Lithologic description

The lithology indicates sedimentation with the presence of silt and clay surmounted by light grey clays and a smoky interspersed with the presence of organic matter. These silt and clay formations have an average thickness of 5 m. They are well sorted, very fine to fine-grained with sub-rounded to rounded and slightly carbonaceous with the presence of rootlets (Figure 2). This lithology reached a depth of 15 m and sedimentation shows from the bottom to the top: milky sand and micromicassed grey silt and clays. Above this set are dark grey clays interspersed with sand (Figure 2).

Pollen grains and spores dominate the palynoflora in the study area but the recovered miospores from the sediment within the study area are pollen of Poaceae (53-152 grains, 32%) and *Elaeis guineensis* (14-61 grains) are dominant while *Laevigatosporites* spp., *Verrucatosporites* sp. 10%, and *Acrostichum aureum* 8% are the most dominant pteridophyte spores. *Rhizophora* spp. (3-6 grains, 0.9%), is a characteristic of mangrove plants of the Niger Delta but are poorly recovered as against subsurface sediments with 15% in the study area (Sowunmi, 1987; Adeonipekun, 2006; Adebayo *et al.*, 2012). Typical rainforest pollen-Sapotaceae 0.2%, *Canthium* sp. 0.2%, and 8% *Brevitricolporiotes guineetii*, are the most common pollen of Niger Delta sediments and are related to the Eagle Island section of the New Calabar River.

Sample 9 is very significant and has the highest diversity of palynomorphs including diatoms and this is followed by the proximal 12 and 14 samples while the distal 1, 2, 3 have the lowest (Figure 3). This is due to the greater impact of the river system discharge in the study area than the other two samples as well also favourable to salinity. The river receives sediments from several rivers from the south and drains into the Atlantic Ocean. Wind current seems to be effective mainly on charred Poaceae cuticles for having poor records in shallow 5, 6, 7, 8, and 9 samples while having high and regular occurrences in the distal and

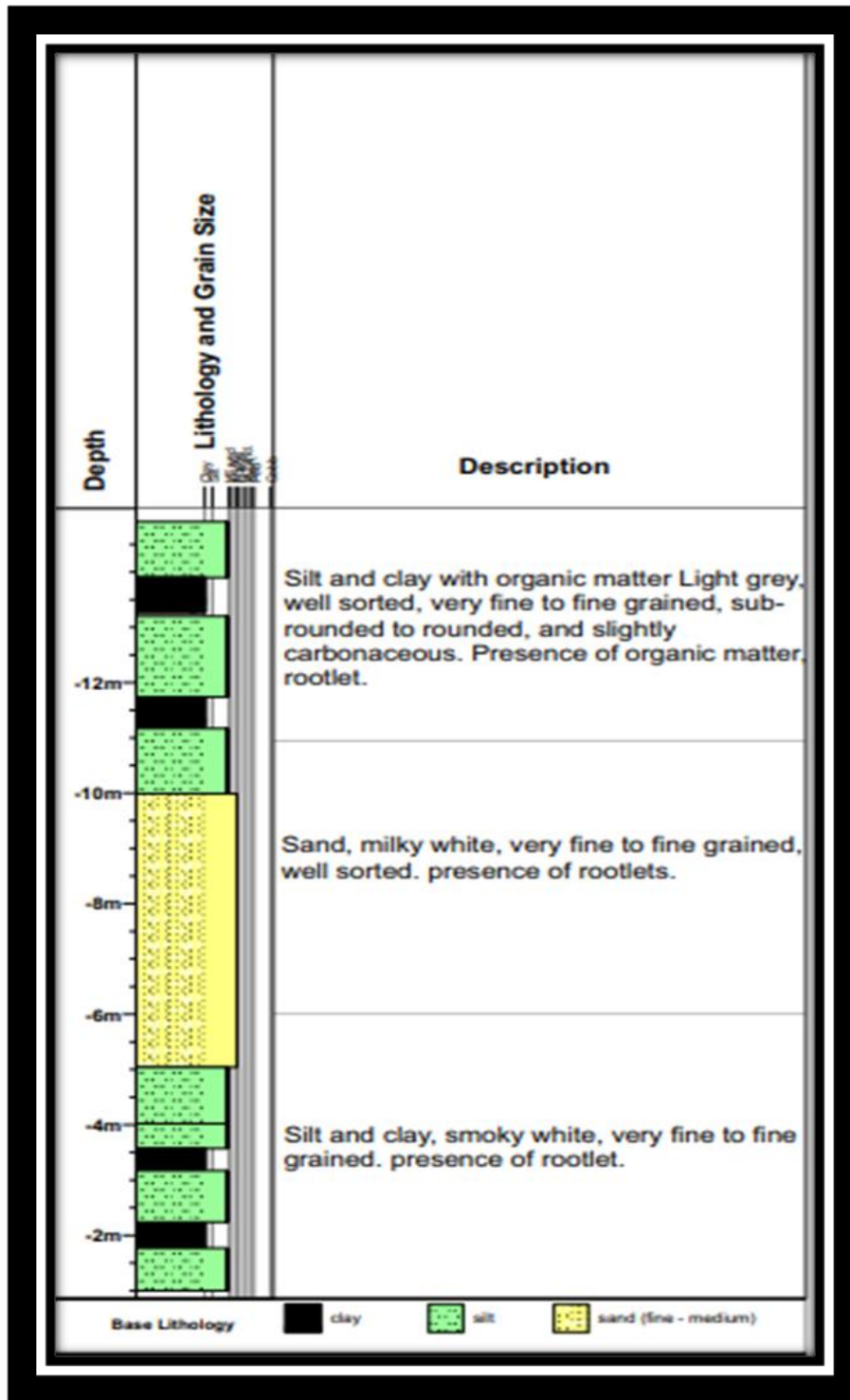


Figure 2. Lithologic description of the study area.

deeper 1, 2, and 3 samples. Also wind impact is of significance which has aided the transport of winged gymnosperm pollen – *Podocarpus milanjanus* with an average of 4 grains (2%) and 6 grains (1%) in 1, 2, 3 and 4, 5, 6, respectively as against 7 and 8 with 3 grains

(0.5%). The record of pollen of Poaceae (Grass) seems enhanced significantly by wind as observed in this work (Figure 4).

Apart from river currents, proximity to shore and shallowness are other determinants involved in the recovery of

fungal elements. This is shown by the highest proportion in the proximal and shallowest 8 and 9 (2.0-5.0) as against 1.0-2.0 grains in the deeper and distal 4, 5, 6 and 1, 2, 3 samples, respectively. The source/provenance of most part of the terrestrial organic matter buried in the sediment is largely from the South-Western part of the Eagle Island section of the New Calabar River, Niger Delta.

Paleoenvironment zones

Zone 1: The total assemblage shows abundance of Foraminifera linings (41.7%) followed by Botryococcus (22%), poaceous cuticular fragments (18.5%) and dinoflagellate cysts (8.5%) dominated by Nematosphaeropsis. The pollen grains and phytoliths show an average of 5.1% and 4.2% of the total count, respectively. Thus, the organic matter derived from terrestrial plants constitutes 49.8% and the marine forms constitute about 50.2% of the total PF's and NPF's count.

Zone 2: In the absence of pollen and very low percentage of poaceous cuticular fragments (13.1) were recorded, high percentage of Foraminifera organic linings (44.3%), Botryococcus (38.9%) and phytolith constituting 3.7% was recorded during this period. The marine palynomorphs constitute an average of 45.8% of the total count constituting Foraminifera linings and dinoflagellate cysts. *Monoporites annulatus* (14%) along with the *Spiniferites* species (9.3%) together constitute 23.3%. *Zonocostites ramonae* increase in percentage, the poaceous cuticular fragments show abundance (16.1%). The pollen grains recorded are of Mangroves (*Rhizophora*, *Sonneratia*), type, *Arecaceae*, *Rosaceae*, *Rutaceae*, and *Poaceae/Cyperaceae*. All these pollen grains represent less than 0.5% of the total count. A very high percentage (33.1%) of *Discoaster spp.* and *Amaurolithus* was also recorded. The Foraminifera organic linings constitute 25.9% followed by *Spiniferites* (5.7%). The total terrigenous matter amounts to about 62.3% and *in situ* marine forms amount to 37.7%. The constituents of terrestrial origin are Botryococcus (18.9%), poaceous cuticular fragments (8.3%), pollen (1.7%) and phytolith (0.4%) along with a high percentage of Neogene nanoplanktons. Among the marine forms Nematosphaeropsis accounts for 17.0% of the total organic matter count. This was followed by Foraminifera linings (16.6%) and *Spiniferites* (4.9%). However, a sudden increase in *Nematosphaeropsis labyrinthea* along with *Tuberculodinium vancampoae* was observed along with a good number of pollens during this period. The pollen grains mainly represent rainforest vegetation along with the mangroves between 87 and 75 ka. Mangroves (*Rhizophora*) comprise an average percentage of 1.2 *Arecaceae* (2.5), *Asteraceae* (0.6) and *Poaceae/Cyperaceae* (16.2).

Zone 3: The poaceous cuticular fragments (dominated by dumbbell-shaped and short-celled phytoliths; pollen/spores and phytolith constitute 8.4, 2.8 and 8.0%, respectively. The pollen grains were not more abundant in

this zone. *Poaceae* and *Cyperaceae* increase in percentage (16.7%). Out of these, the pollen of *Meliaceae* and *Poaceae* increases in percentage. After this period, the stray occurrence of pollen grains was recorded. Foraminifera linings show 25.4% followed by 1.6% of *Spiniferites*. During this period presence of *Verrutricolporites rotundiporus* and *Psilamonocolpites* sp was observed.

Zone 4: The terrestrial input in the sediment was 25.1% which constituted poaceous cuticular fragments (dominated by dumbbell-shaped and short-celled phytoliths) followed by Botryococcus, pollen and spore constituting 12.7, 8.6, 1.6 and 0.7%, respectively. However, Botryococcus shows its abundance, the terrestrial forms constitute 48.9% and the rest 51.1% constitute marine forms out of the total count which is similar to that of Botryococcus and foraminifers. Pollen percentage is high while spore is low and could not be counted for quantitative analysis. Poaceous cuticles dominated by the *Pooideae* sub-family show high percentage of the total biotic remains and both foraminifera linings show abundance. The period shows a good percentage of Pliocene assemblage along with a high frequency of Botryococcus, Foraminifera lining and poaceous cuticle.

Zone 5: The poaceous cuticular fragments constitute 34.8% (dominated by short-celled phytoliths followed by dumbbell-shaped phytoliths) followed by low occurrence of pollen (3.9%), Botryococcus (3.1%) and phytolith (2.9%). An abrupt high peak (30.7%) of Botryococcus was recorded. The reworked Neogene nanoplanktons were observed in low percentage (3%) during this period. Among the marine forms, the Foraminifera organic linings (38.9%) and *Spiniferites* (13.4%) show high percentage. Nematosphaeropsis were not recorded. Thus, the total terrestrial input was 47.7% and the marine forms were 52.3%. This zone shows abundant occurrence of pollen grains belonging to families *Chenopodiaceae/Amaranthaceae*, etc.

Zone 6: This zone is characterized by a high percentage of poaceous cuticles (29%) that were burnt, microscopic charcoal type of organic debris (Figure 3). Total foraminifera linings were high (47.4%). The *Spiniferites* dinoflagellate cysts show a comparatively high percentage (9.2%). The pollen and Botryococcus show low percentages constituting 8.7, 2.4 and 3.2%, respectively. Total terrestrial palynomorphs constitute 43.3% and marine forms constitute 56.7%. Although the pollen count was low, the diversity of herbaceous plant species was recorded in the assemblage along with a few arboreals. These include; *Poaceae/Cyperaceae*.

Paleoclimatic implication within the Eagle Island section of the New Calabar River

A wet condition is suggested for the Eagle Island section

of the New Calabar River on account of the regular occurrence of mangrove pollen, abundant freshwater algae and brackish water swamp species. However remarkable increase in the Gramineae pollen and a rare record of humid climatic indicator, *Cyperraceapollis* spp., allow the interpretation of a tropical humid climate with irregular rainfall. Mozardec-Kerfourn (1992) while working on the deep-sea sediments of the West African margin attributed the dominance of *Operculodinium centrocarpum* and *Polysphaeridium zoharyi* to lowered sea levels following glacial maxima. In another consideration, Udeze and Oboh-Ikuenobe (2005) linked *Operculodinium centrocarpum* observed among palynological data from the Cape Basin of South Africa to warm climate. With the flourishing of mangrove and freshwater forms in this unit, it is therefore inferred that sediment deposition is in a shallow marine environment with frequent freshwater incursions. The unit between 5 to 10 m is a dry climatic phase with warm temperatures as indicated with the increase in the quantities of *Monoporites annulatus*. Vermoere *et al.* (1999) in a study in SW Turkey reported that high percentages of Gramineae pollen types in sediment point to drier local conditions. There was a noticeable presence of the savannah species *Echitricolporites spinosus*, which further confirms the prevalence of a dry climate. Other important savanna species occurring within this zone include *Concentricytis* spp., *Proteacidites* spp., *Cyperaceapollis* spp., *Corylus* spp., *Pteris* spp., *Chenophodipollis* spp., and more. However, a few rainforest/fresh water swamp species are recorded which include *Canthium* spp., *Brevitricolporites guinetii*, *Psilatricolporites operculatus* and a rare to common record of *Botryococcus braunii*. The occurrence of small quantities of mangrove pollen in this zone is probably due to minor local short-lived transgressions of the sea. The pollen record within depth slice 11m to 15m indicates a rise in sea level and an extension of mangrove swamps. It has been reported that high values of *Zonocostites ramonae* characterize periods with a high sea level (Lezine and Vergnaud- Grazzini, 1993; Crowley and Gagan, 1995). The preponderance of ferns and occurrence of Cyperaceae in this zone coupled with the presence of fresh water swamp forest species indicate a dominance of wet and humid conditions that supported ample vegetation. Nevertheless, a substantial occurrence of Gramineae pollen, *Monoporites annulatus* and a few savannah species like *Corylus* spp. indicate fluctuation in environmental conditions within the Eagle Island section of the New Calabar River.

Paleoecology and pollen assemblage of the Eagle Island section of the New Calabar River

The paleoecological study of the study area shows the presence of the pollen grains of the Arecaceae (*Retitricolporites irregularis*, *Monocolpopollenites* sp.),

Nypa (*Monocolpites marginatus*, *Racemonocolpites* hians), Meliaceae (*Psilastephanocolporites punctatus*), Moraceae (*Momipites* sp.), Polygalaceae (*Psilastephanocolporites perforatus*), Caesalpiniaceae (*Striatopollis bellus*), Alchorneas (*Psitricolporites operculatus*), *Psilatricolporites crassus*) and Fabaceae (*Crototricolporites densus*). These pollen grains are associated with spores of Polypodiaceae (*Laevigatosporites ovatus*, *verrucatosporites usmensis*) and Cyatheaceae (*Deltoidospora minor*). These different botanical groups can be divided into three paleoecological groups: mangrove groups, rainforest groups, and coastal plain groups (including swamp species).

Mangrove group: The main mangrove elements identified in this study are *Psilatricolporites crassus* (Apocynaceae), *Psilatricolporites laevigatus*, *Cyathidites minor* and *polypodiaceosporites regularis*. *Psilatricolporites crassus* and *Psilatricolporites laevigatus* are important elements of mangroves widespread throughout tropical Africa and South America (Germeraad *et al.*, 1968; Graham, 1997; Rull, 2001; Bankole *et al.*, 2016) (Table 1). The *Psilatricolporites crassus* pollen is believed to be derived from the mangrove plant *Pelliceria* (Rull, 2001; Graham, 1997). Ferns of the genus *Cyathidites minor* and *Polypodiaceosporites regularis* present in this 84 group are typical of the dense forests of the coastal plains and are also found in mangrove areas (Bankole *et al.*, 2016; Graham, 1991; Samant *et al.*, 1997).

Coastal plain group (including swamp species): This group is represented by an assemblage consisting of *Pachydermites diederixi*, *Retitricolporites irregularis*, *Verrucatosporites usmensis*, *Laevigatosporites ovatus*, *Monocolpopollenites* sp., *Polypodiaceosporites regularis*, and *Cyathidites minor*. The genus *Pachydermites diederixi* shows a constant occurrence within the area and is associated with the pteridophyte of the genus *Polypodiaceosporites regularis*. This fern spore inhabits coastal wetlands and wetlands (Graham, 1991), the species *Pachydermites diederixi*, which belongs to the family *Symphonia globulifera*, is known to be a dominant species in the coastal marshes of Africa (Germeraad *et al.*, 1968). The species *Retitricolporites irregularis* has been identified as a taxon present in coastal swamp environments (Germeraad *et al.*, 1968). Graham (1991) attributes this same pollen to freshwater swamp forests (Figure 4). Tree ferns such as *Cyathidites minor* (cyatheacea) and *Polypodiaceosporites regularis* (Pteridaceae) inhabit thick tropical forests (Graham, 1991; Samant *et al.*, 1997). The association of *Pachydermites diederixi*, *Verrucatosporites usmensis* and *Laevigatosporites ovatus* indicate freshwater or brackish swamp environments (Rull, 1997). This could probably happen in the freshwater marsh behind the mangrove (Table 2).

Rainforest group: This group consists of *Psilastephanocolporites punctatus*, *Striatopollis bellus*,

Table 1. Ecological groups, species diversity, abundance and marine index values of the study area.

S/N	FWSP	BWSP	SAVANNA	RAIN	FUNG	ALG	MANGROVE
1	4	0	1	9	0	1	0
2	13	7	6	0	4	1	0
3	3	2	0	1	2	4	0
4	2	0	2	1	1	3	0
5	4	2	3	2	0	1	0
6	6	1	6	3	0	1	0
7	5	0	0	1	0	2	17
8	1	3	9	0	0	5	10
9	2	2	1	0	3	3	0
10	3	4	2	5	4	0	0
11	4	0	1	0	1	0	1
12	5	2	0	0	2	0	1
13	7	2	2	2	0	1	4
14	0	5	0	0	2	3	3
15	0	0	0	1	2	4	0

Note: FWSP: Fresh Water Swamp Species; BWSP: Brackish Water Swamp Species; SAVANN: Savannah Species; RAIN: Lowland Rainforest Species, FUNG: Fungi; ALG: Algae.

Table 2. *Monoporites annulatus* and *Zonocostites ramonae* composition of the study area.

S/N	<i>Monoporites annulatus</i>	<i>Zonocostites ramonae</i>	Total	% <i>Monoporites annulatus</i>	% <i>Monoporites annulatus</i>
1	1	-	1	100	0
2	3	6	9	64	36
3	-	--	-	-	-
4	1	3	4	100	0
5	-	1	1	75	0
6	3	-	3	0	100
7	-	2	2	100	0
8	3	-	3	100	0
9	2	--	2	50	50
10	-	1	1	0	100
11	1	-	1	100	0
12	-	2	2	100	0
13	2	2	4	100	0
14	-	1	1	0	100
15	2	-	2	100	0

Psilatricolporites operculatus, *Margocolporites rauvolfii*, *Racemonocolpites hians*, and *Psilatricolporites laevigatus*. Bankole *et al.* (2016) have shown that *Psilastephanocolporites punctatus*, *Racemonocolpites hians*, and *Psilatricolporites laevigatus* are indicative of dense moist forests. Morley *et al.* (1993) attribute the species *Striatopollis bellus* and *Racemonocolpites hians* to the rainforest. Cécile (2013) confirms that *Striatopollis bellus* is a characteristic species of rainforest. Rull (2001) also indicates that the species *Psilatricolporites laevigatus* is a characteristic species of rainforest (Figure 5).

Recovery of freshwater *Pediastrum* is very poor in the studied area marine, although they are frequently recovered abundantly from marine sediments in tropical areas having been washed in by rivers (Brenac and Richards, 2001). However, the poor recovery in this work shows a general deduction for their significance as a guide fossil. Meanwhile, from the few recovered, *Pediastrum* seems to prefer higher energy fluvial settings to low energy areas (Figure 6). The freshwater vegetation has been taken over by saltwater vegetation types hence, the absence of typical freshwater trees such as *Amanoa* sp.

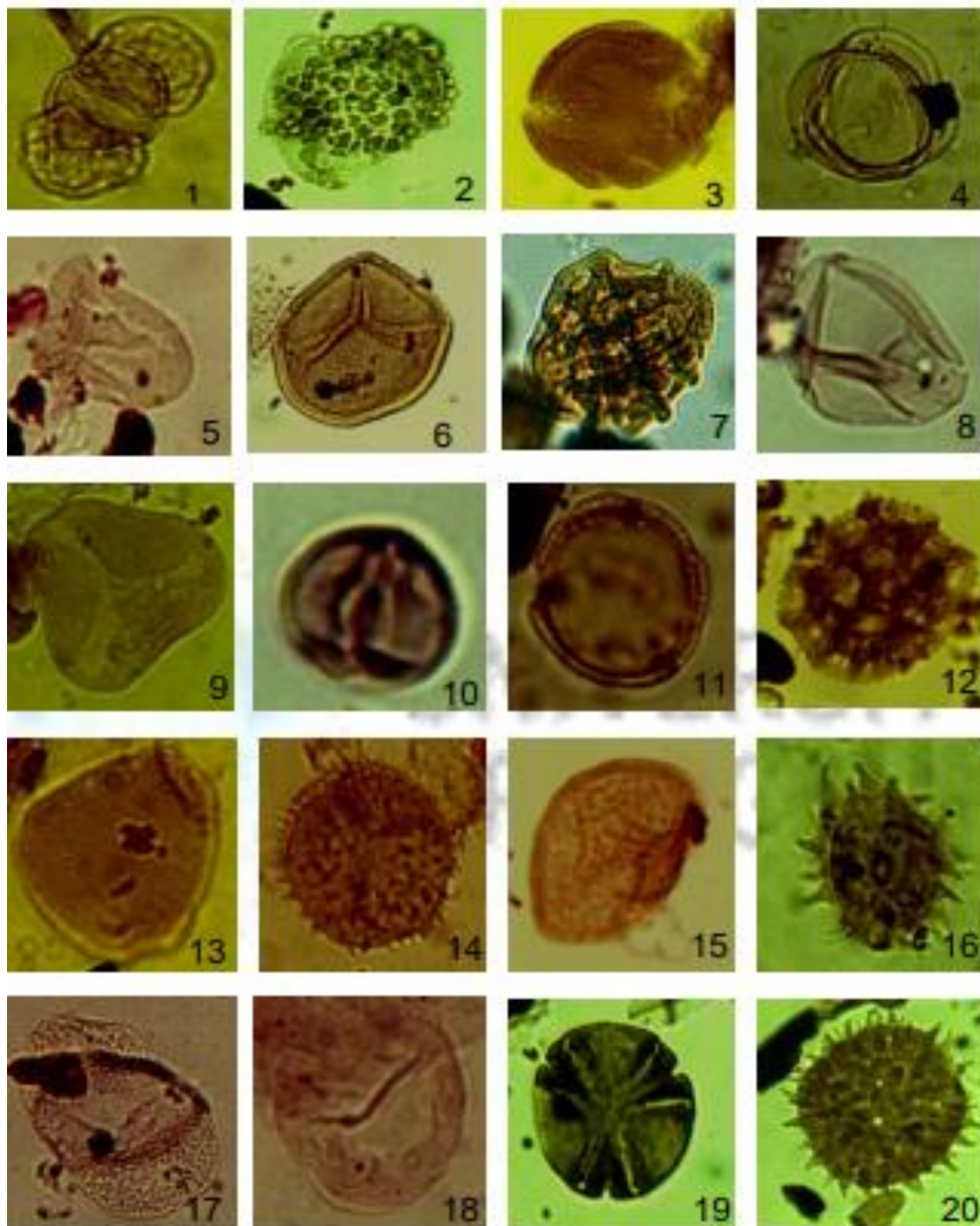


Figure 5. Photomicrographs of palynomorphs in the study area: 1. *Podocarpus milanjanus*, 2. *Gemmamonoporites* sp. 3. *Retistephanocolpites gracilis*, 4. *Nymphaeapollis clarus*, 5. *Cyperaceapollis* sp., 6. *Stereisporites* sp., 7. *Peregrinipollis nigericus*, 8. *Monoporites annulatus*, 9. *Elaeis guineensis*, 10. *Zonocostites ramonae*, (*Rhizophora*), 11. *Retistephanocolpites gracilis* sp., 12. *Fenestrites spinosus* (*Compositae* pollen), 13. *Proteacidites* sp., 14. *Echitriletes "pliocenicus*, 15. *Stereisporites* sp., 16. *Echitricolporites spinosus*, 17. *Podocarpidites* sp., 18. *Gemmamonoporites* sp., 19. *Rauwolfia vomitoria*, 20. *Echiperiporites estalae*.

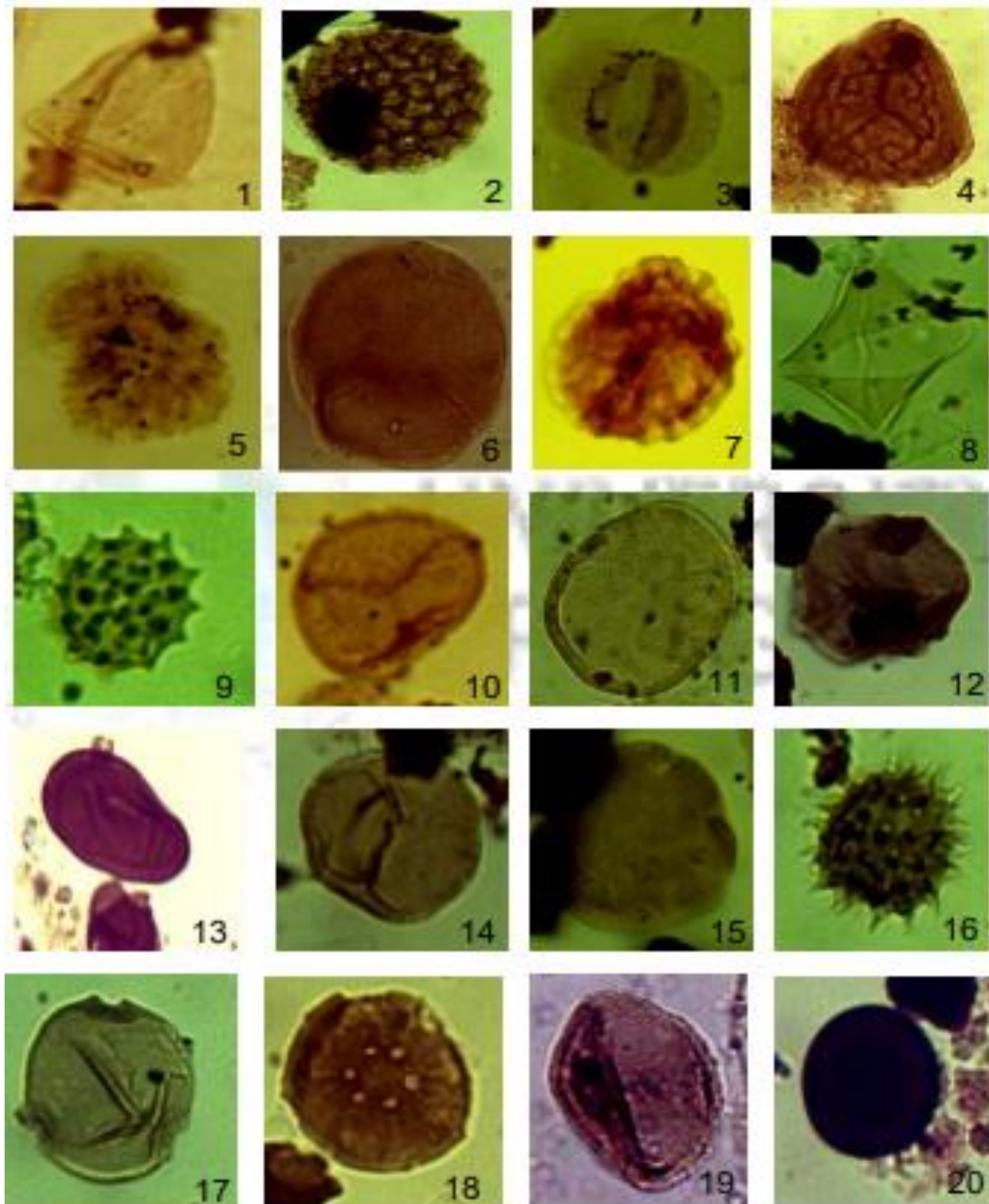


Figure 6. Photomicrographs of palynomorphs in the study area: 1. *Cyperaceapollis* sp., 2. *Polyporina* sp., 3. *Podocarpus milanjianus*, 4. *Triporoletes neogenicus*, 5. *Botryococcus braunii*, 6. *Stereisporites* sp. 7. *Peregrinipollis nigericus*, 8. *Nymphaepollis clarus*, 9. *Tubifloridites antipodica*, 10. *Stereisporites* sp., 11. *Proxapertites cursus*, 12. *Corsinipollenites jussiaeensis*, 13. Fungal spore, 14. *Stereisporites* sp., 15. *Retistephanocolpites gracilis*, 16. *Echitrcolporites spinosus*, 17. *Brevicolporites guinetii*, 18. *Cinctiperiporites mulleri*, 19. *Verrutricolporites rotundiporus* 20. Fungal spore.

(*Retitricolporites irregularis*) and *Symphonia globulifera* (*Pachydermites diderixi*). Ironically, the slow rates of mangrove regeneration and edaphic re-adaptation have impeded its recovery despite the current increasing sea level rise.

Conclusion

The distribution of palynomorphs Recent sediments from Eagle Island section of the New Calabar River has revealed the magnitude of the vegetation of the Niger Delta. This is due mainly to anthropogenic activities of oil exploration, agriculture and urbanization apart from the uncontrollable global warming-induced sea level rise and flooding. High abundant subsurface proportions of *Rhizophora* are different from its extreme low proportion in the Recent sediments. Rainforest and freshwater tree plants have been reduced to the extent that their pollens were minimal from studied samples. Poaceae and *E. guineensis* as well as opportunistic herbs have taken over from the traditional mangrove plants. Processes such as the water currents dominated by the rounded shape sediment and coastal current, combined with the influence of water depth and salinity, the sediment deposition created by glacial erosion in the past and the open marine conditions today, are all influences controlling the distribution of palynomorphs within the Eagle Island section of the New Calabar River. The river system dominates in the transportation of sediments into the ocean by which wind only carries Poaceae, charred Poaceae cuticles and *P. milanjanus*, these significantly could be due to environment and evolutionally factors, considering that it could have originated in these environments, or the major transport agents for palynomorphs in alluvial plain are wind which are deposited in more distal environments freshwater swamp/rain forest, this can be explained by an increase of wind capacity. Current paleogeographic reconstructions support these points.

CONFLICT OF INTEREST

The authors declare they have no conflict of interest.

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