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PALYNOLOGICAL STUDY OF RECENT SEDIMENTS FROM AJIDO, BADAGRY COASTAL ENVIRONMENT OF LAGOS, SOUTH-WESTERN NIGERIA

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ABSTRACT

A palynological study was conducted on recent sediments from the coastal area of Ajido in Badagry, Lagos State, Nigeria, in order to provide inferences on the past vegetation and climate in the area. Sediment samples were collected at different depths using the universal peat corer into sealed sample bags and treated using standard palynological procedures, and palynomorphs were isolated. This was followed by slide preparation and microscopic study of the treated residues and photomicrographs of some recovered palynomorphs were also taken using a Novex light microscope at X400 and X1000, respectively. The results yielded a recovery of different palynomorphs, including pollen of *Elaeis guineensis* Jacq, *Alchornea cordifolia* Müll.-Arg, *Symphonia globulifera* Linn; others were *Acrostichum aureum* Linn, *Ceratopteris* sp, *Amanoa* sp, *Nephrolepis* sp. *Cyclosorus afer* Mill, species from Euphorbiaceae, Acanthaceae, Poaceae, Asteraceae and Malvaceae were also recovered. The recovery of *Symphonia globulifera*, *Ceratopteris* sp., *Acrostichum aureum* Linn, *Nephrolepis* sp. and *Cyclosorus afer* Ching suggest an establishment of fresh water swamp forest vegetation, while the presence of *Elaeis guineensis*, Asteraceae and species from Poaceae are suggestive of secondary forest type, influenced by anthropogenic activities. It was, however, observed that fossil plants like *Acrosticum aureum*, *Cyperus* sp, Poaceae, *Elaeis guineensis*, Euphorbiaceae, Asteraceae and *Coco nucifera* Linn, represented in this study are still found in our present day environment, hence the inferred period for this study is designated as late Holocene. Fluctuation between wet and dry climatic conditions in the Holocene of this area is inferred from this study.

KEY WORDS: Palynomorphs, Holocene, Climate, Ajido, Badagry.

INTRODUCTION

Pollen preserved in sediments or peat bogs have been used to reconstruct past vegetation and to infer the paleoenvironment with respect to changes in climate over time particularly when integrated with lithological studies (Chen *et al.*, 2009). Also, the quantitative analysis of these fossil palynomorphs from various layers or horizons of sediments have been used in reconstructing past vegetation distribution and abundance (Sowunmi, 1995; Adekanmbi and Sowunmi, 2007; Durugbo *et al.*, 2010). This information provides important baseline data for understanding long-term ecosystem dynamics and for the calibration of earth system process models such as regional scale environmental changes (Germeraad *et al.*, 1968). According to Ivanor *et al.* (2007), the distribution pattern of vegetation strongly depends on climatic conditions and thus vegetation reconstructions help to understand past climates. Sowunmi (1987) reported that a close relationship exists between vegetation and other components of the environment, particularly climate and soil. She further affirmed that flora of an area provides a good reflection of the major climatic regime of that area. The effect of climate on other components of the environment is very considerable to the extent that every particular climatic zone has its own characteristic vegetation type. Therefore, plants are among the best indicators of the environment especially of the climate, soil and fauna. Certain individuals or assemblages of plants are known to be characteristic of specific ecological zones and the occurrence of fossils of such ecological indicator species in sediments is considered a reflection of contemporary ecological conditions.

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Most palynological studies in Nigeria have been largely confined to the Niger Delta due to the search for oil; hence there is a dearth of information from previous comprehensive studies geared towards the reconstruction of changes in vegetation and paleoclimatic conditions. Sowunmi (2004) studied an 11 m terrestrial core from Ahanve village in Badagry coastal environment. Adekanmbi and Ogundipe (2009b) compared pollen assemblages recovered from shoreline, Lagoon floor and Land sediments from Lagos Lagoon. Orijemie (2013) and Orijemie and Sowunmi (2014) carried out some archaeological and palynological works in the same area. Apart from these works, no palynological work known to the authors has been carried out in the Lagos coastal environment. In addition, the vegetation of Nigerian coastal environment is frequently degraded, consequent of which many plant species are now extinct or lost in our present-day environment (Adekanmbi and Ogundipe, 2009a). This necessitated the present study with a view to investigate and reconstruct the paleovegetation and climate of Ajido coastal environment in Lagos, Nigeria.

MATERIALS AND METHODS

Description of the study area

Ajido is a village located at Longitude 3° 00 24" E, Latitude 6° 40 44" N in Badagry Local Government Area of Lagos State. It was founded around the 18th century by Aholu Sagbe and comprised mostly of the Egun people and some Ijaw migrants with a minority of Ghanaians. (Verbal information obtained from the Aholu, chief of Ajido community) The probable catchment comprises of the vegetation complex around the site including the Atlantic coast, the Badagry area and, to a less extent, the region traversed by the River Yewa with Badagry Creek. The present vegetation is dominated by *Typha latifolia* Linn, *Eichhornea crassipes* Mart, *Cocos nucifera* Linn, *Cyperus* sp., *Phoenix reclinata* Jacq. and *Acrostichum aureum* Linn. Sampling points were selected within Ijegeme, 300 m away from the Ajido jetty of this area.

Sample collection

A total of 18 sediment samples were collected at 3 cm interval to a depth of 51 cm, using a universal peat corer and transferred into sealable sample bags, following Jordan *et al.* (2010). The samples were subjected to palynological, lithological and pH analyses. A vegetation reconnaissance of the study site was carried out and the position of the sampling point was determined using a global positioning system. The map of the location was developed by using Arc GIS software (Fig 1).

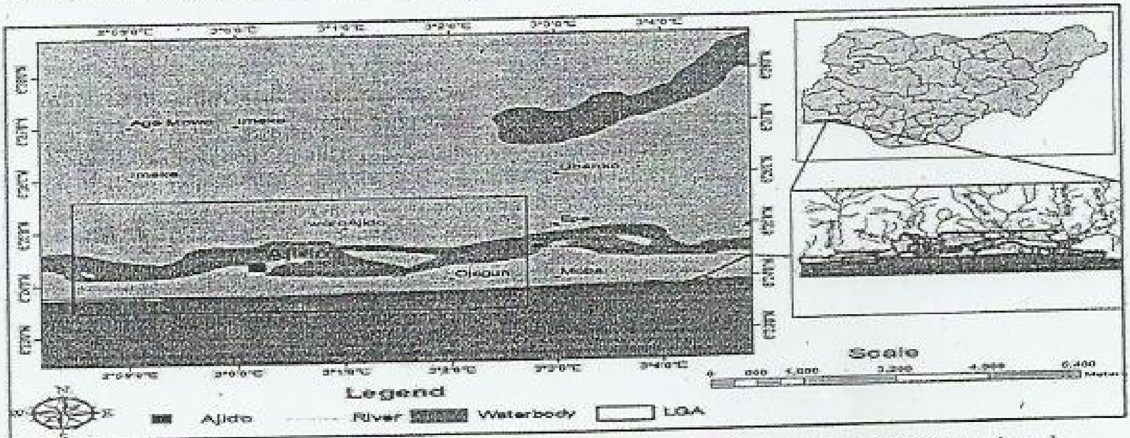

Figure 1: Map of the study Location (Source) This map was made by the author for the purpose of this research work.

Pollen preparation

The sediment samples were treated using standard palynological methods. These include Hydrofluoric acid (HF) treatment for the removal of siliceous materials; Hydrochloric acid (HCl) for the removal of carbonaceous materials; Heavy liquid separation for the separation of palynomorphs from sediments and finally acetolysis to destroy cellulosic materials and darken palynomorphs for easy identification (Faegri and Iversen, 1989).

Pollen identification

Identification of pollen grains and spores was achieved by studying their morphological characteristics such as apertures (pores and colpi), shape (prolate, oblate, spherical, triangular), size, surface structure and ornamentation. Their morphological characteristics were compared with published description keys of African pollen grains and spores, which included Sowunmi (1995, 1973), Bonnefille and Riollet (1980), Salard-Cheboldaeff (1986), Willard *et al.* (2004), Gosling *et al.* (2013), pollen albums and reference collections in the Department of Botany, University of Lagos.

pH test and Lithology

The pH values of the sediment samples were determined in order to investigate their acidity or alkalinity with the aid of a digital pH meter. To calibrate the pH meter, standardized pH solutions of 4 and 9 were used. Five (5) grams of each sample was dissolved in distilled water in plastic cups, stirred and shaken vigorously to form a solution. The pH electrode was then inserted into the solution and values were noted on the pH meter and recorded.

The lithological analysis was done by washing the sediments with distilled water using a 63 mm sieve. The sediments were oven-dried, examined and described with the aid of Grain Size Comparator, Grain Size Analyser, Rock Colour Chart, stereo binocular microscope and hand-held magnifying lens at X40 magnification. The pollen diagram (Figure 1) was constructed using Tilia graph computer software after Grimm (1991). Statistical analyses including mean, standard deviation, student T-test, one-way Analysis of Variance (ANOVA) and correlation analysis were performed on the different ecological groups.

RESULTS AND DISCUSSION

The palynological analysis revealed a recovery of 1,696 palynomorphs, comprising forty-four different pollen types. Palynomorphs were identified to familial, generic and species levels. Others that could not be identified were referred to as "indeterminate". Forms identified to species levels include those with distinctive pollen types such as *Rhizophora* sp. *Avicennia* sp.*Symphonia globulifera*, *Cleistopholis patens*, Chenopodipodiaceae/Amanranthaceae, *Cyperus* sp. and *Nymphea lotus* (see Table 2). Pteridophyte spores dominated the palynofloral assemblage with 932 (54.9 %) palynomorphs; other represented plant taxa include *Cyperus* sp.78 (4.59 %), Poaceae 66 (3.89 %), *Rhizophora* sp. 57 (3.36 %), Arecaceae 51(3 %), *Nymphaea* sp 47 (2.77 %); others include *Acrostichum aureum* 41(2.42 %), *Elaeis guineensis* 33 (1.95 %), Asteraceae 32 (1.88 %) *Symphonia globulifera* 23(1.36 %), Acanthaceae 18(1.1 %), Chenopodiaceae/Amaranthaceae 17(1 %). Microforaminiferal wall linings 18 (1.1 %) and fungal spores 83 (4.89 %) were also recovered (Table 2 and Figure 2). The highest number of palynomorphs dominated by *Laevigatosporites* and Arecaeae was recorded at depth 12-15 cm while the lowest number of palynomorphs was recorded at depth 48 - 51 cm.

The pH analysis of the sediments showed that they were generally acidic, ranging between 3.51 and 6.70 at the surface depth, lending credence to the relatively higher recovery of palynomorphs, since pollen and spores thrive well in acidic environments. The lithological analysis of sediments (Table 1) revealed that the topmost section of the core to the deeper part is characterized by mudstones, which are usually dark, soft/moderately hard and non-fissile bodies. The dominance of shale suggests an establishment of a mangrove swamp forest during the period of sedimentary deposition. The lithological properties are light grey, fine grained, angular and very well sorted sandy bodies. The textural features varied from sub-angular to rounded, moderately well sorted with abundant carbonaceous detritus and ferruginous materials indicating these sand bodies have been deposited under continental environments.

Table 1: Results of pH, salinity, recovered palynomorphs, diversity and lithology for the study location

Depths (cm)	pH	Recovered Pollen	Diversity	Lithological Descriptions
Surface	6.70	135	16	Mudstones (>90%): Dark, soft/moderately hard and non-fissile Sand (<10%): Light grey, fine grained, angular and very well sorted
0-3	5.12	59	14	Mudstones (>85%): Dark, soft/moderately hard and non-fissile Sand (<15%): Light grey, fine grained, angular and very well sorted
3--6	4.52	92	16	Mudstones (>85%): Dark, soft/moderately hard and non-fissile Sand (<15%): Light grey, fine grained, angular and very well sorted
6--9	4.80	11	10	Mudstones (>85%): Dark, soft/moderately hard and non-fissile Sand (<15%): Light grey, fine grained, angular and very well sorted
9--12	4.04	452	26	Mudstones (>95%): Dark, soft/moderately hard and non-fissile Sand (<5%): Light grey, fine grained, angular and very well sorted
12--15	4.68	473	27	Mudstones (>95%): Dark, soft/moderately hard and non-fissile Sand (<5%): Light grey, fine grained, angular and very well sorted
15--18	4.93	65	10	Mudstones (>98%): Dark, soft/moderately hard and non-fissile Sand (<2%): Light grey, fine grained, angular and very well sorted
18--21	4.72	152	18	Mudstones (>98%): Dark, soft/moderately hard and non-fissile Sand (<2%): Light grey, fine grained, angular and very well sorted
21--24	4.18	29	11	Mudstones (>80%): Dark, soft/moderately hard and non-fissile Sand (<20%): Light grey, fine grained, angular and very well sorted
24--27	3.79	39	14	Mudstones (>80%): Dark, soft/moderately hard and non-fissile Sand (<20%): Light grey, fine grained, angular and very well
27--30	3.76	58	19	Mudstones (100%): Dark, soft/moderately hard and non-fissile
30--33	3.97	44	15	Mudstones (100%): Dark, soft/moderately hard and non-fissile
33--36	4.70	33	15	Mudstones (100%): Dark, soft/moderately hard and non-fissile
36--39	4.25	19	11	Mudstones (>80%): Dark, soft/moderately hard and non-fissile Sand (<20%): Light grey, very fine/fine grained, angular and well sorted
39--42	3.64	11	8	Mudstones (>95%): Dark, soft/moderately hard and non-fissile Sand (<5%): Light grey, very fine/fine grained, angular and well sorted
42--45	3.56	11	7	Sand (>90%): Light grey, very fine/fine grained, angular and well sorted Mudstones (<10%): Dark, soft/moderately hard and non-fissile
45--48	3.53	13	8	Sand (>98%): Light grey, very fine/fine grained, angular and well sorted Mudstones (<2%): Dark, soft/moderately hard and non-fissile.
48--51	3.51	5	5	Sand (>90%): Light grey, very fine/fine grained, angular and well sorted Mudstones (<10%): Dark, soft/moderately hard and non-fissile

Table 2: Pollen Spectra Recovered From the Study Location

	LOCATION (T) AJIDO																					
		Depths (CM)																				
S/N	Palynomorphs (Families)	Surface	0 - 3	3 – 6	6 – 9	9 – 12	12 – 15	15 – 18	18 – 21	21 – 24	24 – 27	27 – 30	30 – 33	33 – 36	36 – 39	39 – 42	42 – 45	45 – 48	48 – 51	Total Sum	Rel Freq.	% OCC
1	*Elaeis guineensis* (Arecace	1	3	*	*	4	8	*	7	4	2	3	*	*	*	*	*	1	1	34	0.5	2
2	Adiantiaceae (Pteris)	1	*	*	*	*	*	1	*	2	*	*	2	1	*	*	*	*	*	7	0.28	0.41
3	Rhizophoraceae	1	4	8	*	6	14	*	8	*	3	2	3	3	4	*	3	*	*	57	0.67	3.35
4	*Laevigatosporites sp*	3	32	54	1	378	355	18	47	*	6	22	7	6	1	2	*	*	*	932	0.78	54.76
5	Fungal spore	22	1	3	2	6	2	16	3	3	8	4	8	*	3	*	2	*	*	83	0.78	4.88
6	Poaceae	32	*	3	1	14	3	*	3	3	1	3	2	*	*	*	1	*	*	66	0.61	3.88
7	*Alchornea sp* (Euphorbiaceae)	1	*	*	1	*	2	*	2	4	*	1	*	*	*	*	*	*	1	12	0.39	0.71
8	*Acrostichum aureum* (Pterid	1	1	2	*	1	13	1	6	3	2	2	2	*	1	2	1	3	*	41	0.83	2.41
9	Olacaceae	1	*	*	*	*	5	1	2	*	2	*	1	1	*	1	*	*	*	14	0.58	0.82
10	*Avicennia sp* (Avicenniaceae)	4	*	2	*	3	2	*	1	*	*	*	*	*	*	*	*	*	*	12	0.28	0.71
11	Mimosaceae	8	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	8	0.06	0.47
12	*Symphonia globulifera* (C	12	*	*	*	2	4	*	2	*	*	*	2	*	1	*	*	*	*	23	0.33	1.35
13	Asteraceae	13	*	*	1	6	4	*	2	*	1	*	*	*	*	*	*	*	*	32	0.33	1.88
14	Chenopodiaceae/Amaranthaceae	8	*	1	1	1	2	*	*	*	1	*	2	*	*	1	*	*	*	17	0.44	1
15	Acanthaceae	12	*	5	1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	18	0.17	1.06
16	*Selenopemphix sp.* (Algae)	*	2	*	*	1	2	*	*	*	*	*	1	3	*	*	1	*	*	10	0.33	0.59
17	*Cyperus sp* (Cyperaceae)	10	2	3	*	*	3	1	35	*	4	6	1	7	2	2	2	*	*	78	0.72	4.58
18	Microforaminiferal wall living	*	5	1	*	2	2	*	2	*	*	1	1	1	*	*	*	3	*	18	0.5	1.06
19	*Borreria sp* (Rubiaceae)	*	1	*	*	1	*	1	*	*	*	*	1	*	*	*	*	*	*	4	0.22	0.24
20	Dinocysts	*	1	1	*	*	*	*	*	*	*	1	*	2	*	1	1	*	*	7	0.28	0.41
21	Pollen indeterminate	*	2	3	1	1	6	4	3	4	4	2	*	3	1	1	*	1	*	36	0.78	2.12
22	Trilete spore	*	2	1	1	6	*	*	*	*	*	*	*	*	*	*	*	*	*	10	0.22	0.59
23	Euphorbiaceae	*	2	2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	4	0.11	0.24
24	Spore	*	1	*	*	*	*	*	*	1	*	*	*	*	*	*	*	*	*	2	0.11	0.12
25	Palmae or Arecaceae	*	*	2	*	1	24	12	7	*	*	*	4	*	*	*	*	1	*	51	0.39	3
26	*Sphagnum sp* (Sphagnaceae)	*	*	1	*	3	2	*	2	*	*	1	3	1	*	*	*	*	*	13	0.39	0.76
27	*Lomatia ilicifolia* (Prote	*	*	*	*	2	*	*	*	*	*	*	*	*	1	*	*	*	*	3	0.11	0.18
28	Azolla (Salviniaceae)	*	*	*	1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	1	0.06	0.06
29	Dinoflagellate cysts	*	*	*	*	1	1	2	*	*	*	*	*	*	*	*	*	*	*	4	0.17	0.24
30	Monocolpites sp	*	*	*	*	3	*	*	*	*	*	*	*	*	2	*	*	1	*	6	0.17	0.35
31	*Ceratopteris sp* (Pteridacea	*	*	*	*	2	*	*	*	*	1	*	*	*	*	*	*	*	*	3	0.11	0.18
32	Inaperturate pollen	*	*	*	*	2	3	2	*	2	*	1	*	1	*	*	*	*	*	11	0.33	0.65
33	*Celtis sp* (Ulmaceae)	*	*	*	*	1	*	*	*	*	*	*	*	*	*	*	*	*	*	1	0.06	0.06
34	*Leiosphaeridia sp*	*	*	*	*	1	2	*	*	*	*	1	2	1	*	*	*	*	*	7	0.28	0.41
35	Polypodiaceae	*	*	*	*	*	1	*	*	*	*	*	*	*	*	*	*	*	*	1	0.06	0.06
36	*Nymphaea sp.* (Nymphaeaceae)	*	*	*	*	6	9	2	18	*	3	3	2	1	1	1	*	1	1	48	0.67	2.82
37	Marantaceae	*	*	*	*	*	1	*	*	*	*	*	*	*	*	*	*	*	*	1	0.06	0.06
38	Proteaceae	*	*	*	*	*	1	*	*	*	*	*	*	*	*	*	*	*	*	1	0.06	0.06
39	Spiniferites sp (Dinoflagelate)	*	*	*	*	*	1	*	*	*	*	*	*	*	*	*	*	*	*	1	0.06	0.06
40	Pediastrum sp (Algae)	*	*	*	*	*	1	*	*	1	*	*	*	*	*	*	*	*	*	2	0.11	0.12
41	*Cleistopholis patens* (Ann	*	*	*	*	*	*	2	*	*	*	*	*	*	*	*	*	*	*	2	0.11	0.12
42	*Kigelia Africana* (Bignoniace	*	*	*	*	*	*	1	*	*	*	*	*	*	*	*	*	*	*	1	0.06	0.06
43	Aplanospore	*	*	*	*	*	*	1	2	2	*	*	*	*	*	*	*	*	1	6	0.22	0.35
44	*Stenochlaena palustris* (B	*	*	*	*	*	*	*	*	*	1	1	*	*	*	*	*	2	*	4	0.17	0.24
45	Charred gramineae cuticle	*	*	*	*	*	*	*	*	*	*	2	*	1	2	*	*	*	*	5	0.17	0.29
46	*Hibiscus tiliaceus* (Malva	*	*	*	*	*	*	*	*	*	*	1	*	*	*	*	*	*	*	1	0.06	0.06
47	*Polysphaeridium sp.* (Alg	*	*	*	*	*	*	*	*	*	*	1	*	*	*	*	*	*	1	2	0.11	0.12
48	*Acacia sp* (Fabaceae)	*	*	*	*	1	*	*	*	*	*	*	*	*	*	*	*	*	*	1	0.06	0.06
49	Malvaceae	*	*	*	*	*	*	*	*	*	*	*	*	1	*	*	*	*	*	1	0.06	0.06
	TOTAL	135	59	92	11	453	473	65	152	29	39	58	44	33	19	11	11	13	5	1702		100

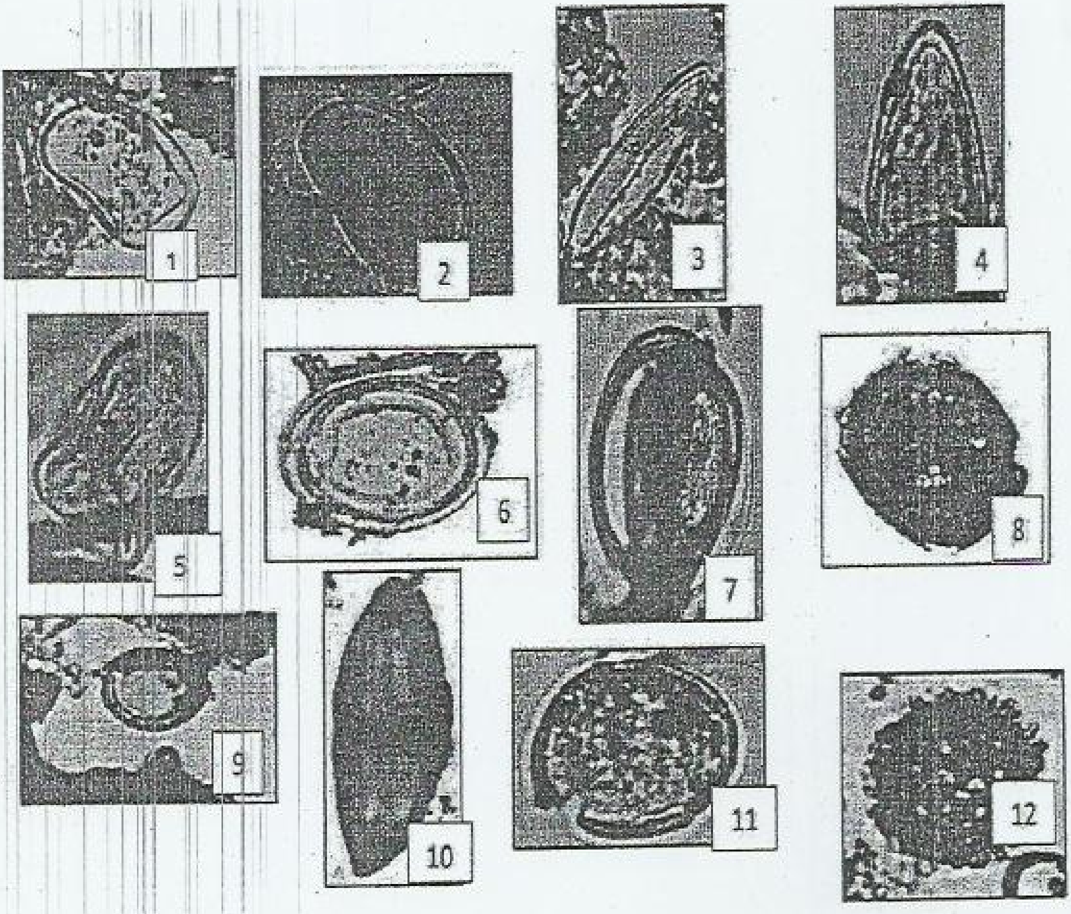

Plate 1: Photomicrographs of some recovered palynomorphs: 1 & 2 *Laevigatosporites sp.* 3. *Palmae*, 4 & 5 *Cyperus sp*, 6 & 7 *Nymphea sp*, 8 *Symphonia globulifera*, 9&11 *Pollen indeterminate*, 10 Fungal spore, 12 *Amanoa* sp.

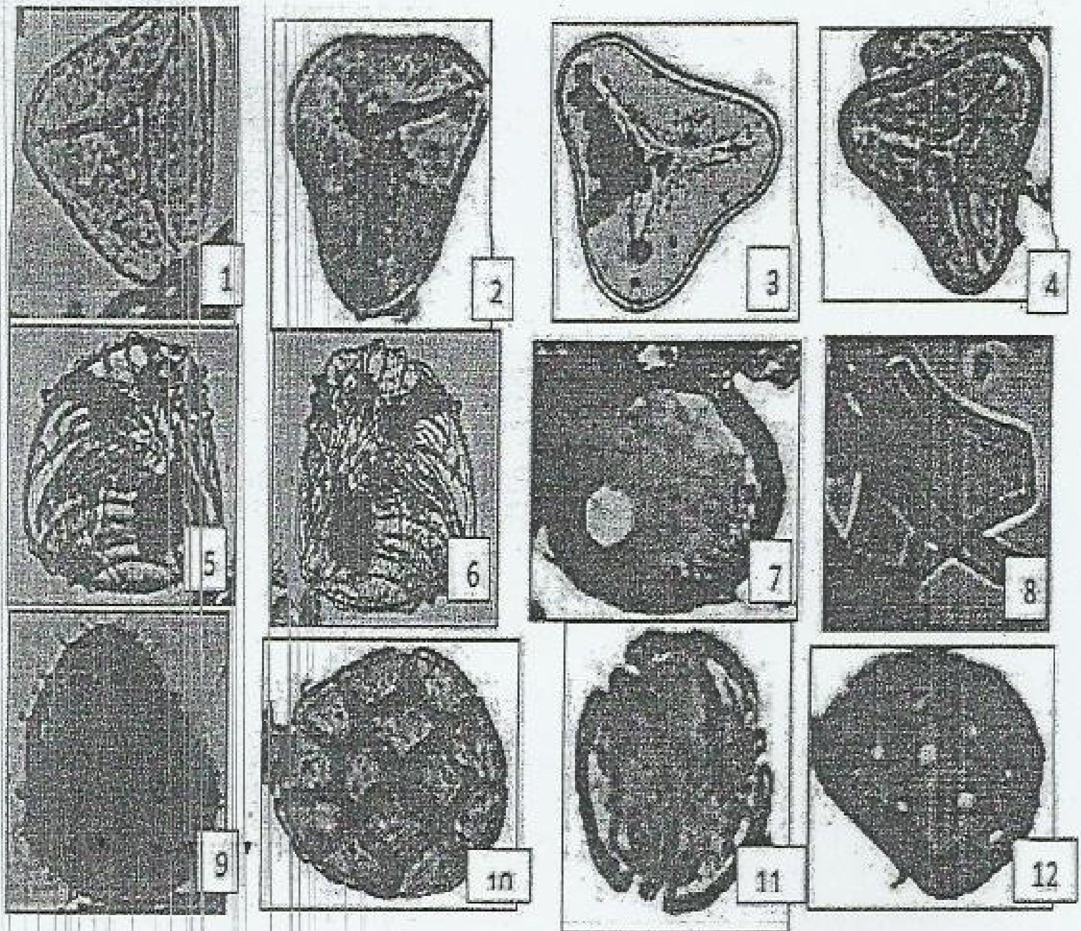

Plate 2: Photomicrographs of some recovered palynomorphs: 1-2 ***Acrostichum aureum*** 3-4 *Elaeis guineensis*, 5&6 *Ceratopteris sp*, 7 *Symphonia globulifera*, 8 *Lomatia cf. ilicifolia*, 9 Maratiaceae 10 *Acacia sp.* 11 *Alchornea cordifolia* 12 Chenopodiaceae /Amaranthaceae

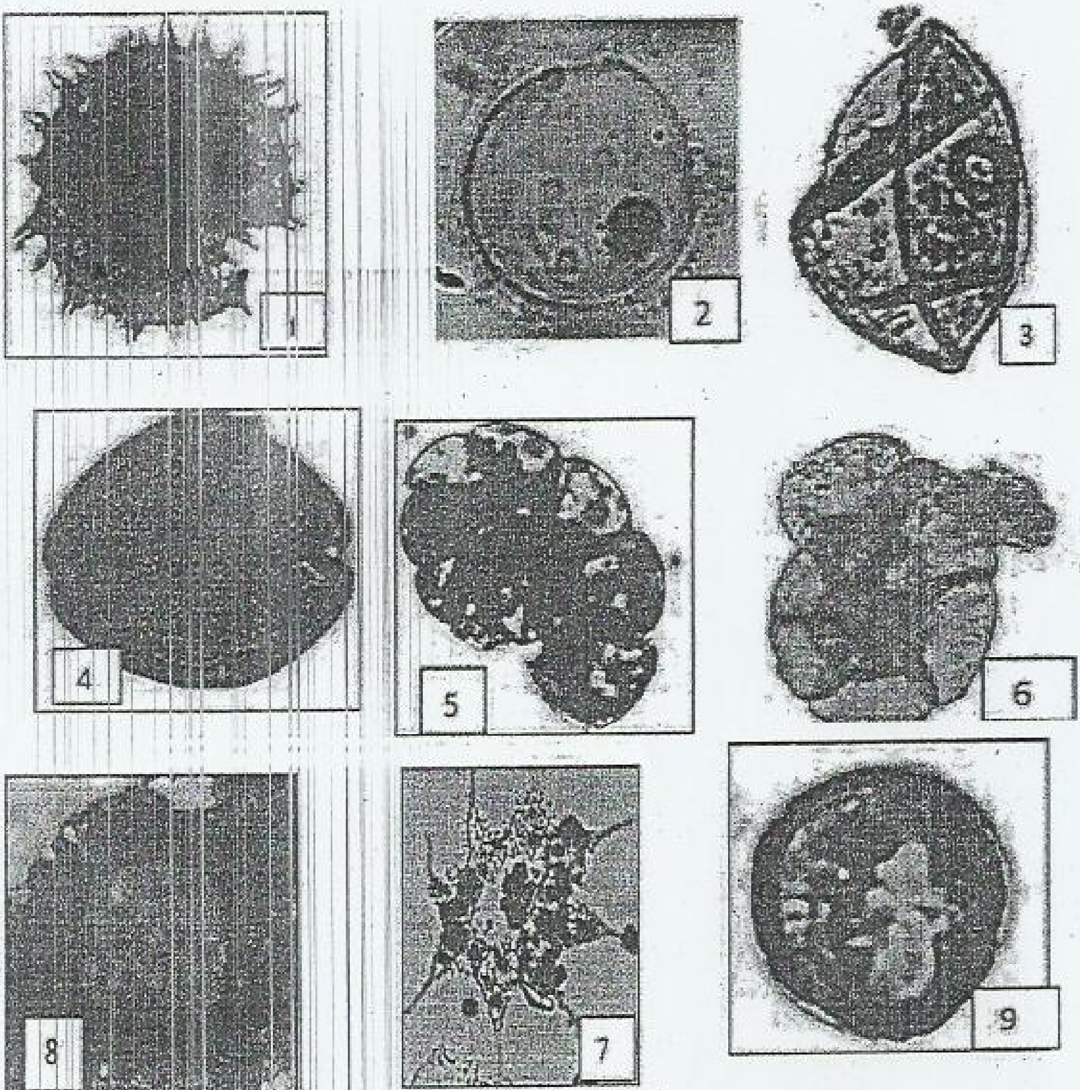

Plate 3: Photomicrographs of some recovered palynomorphs: 1 Malvaceae, 2&3 Poaceae, 4 *Borreria sp.*, 5&6 *Microforaminiferal wall linings*, 7 *Pediastrum* sp., 9&10 Pollen Indeterminate

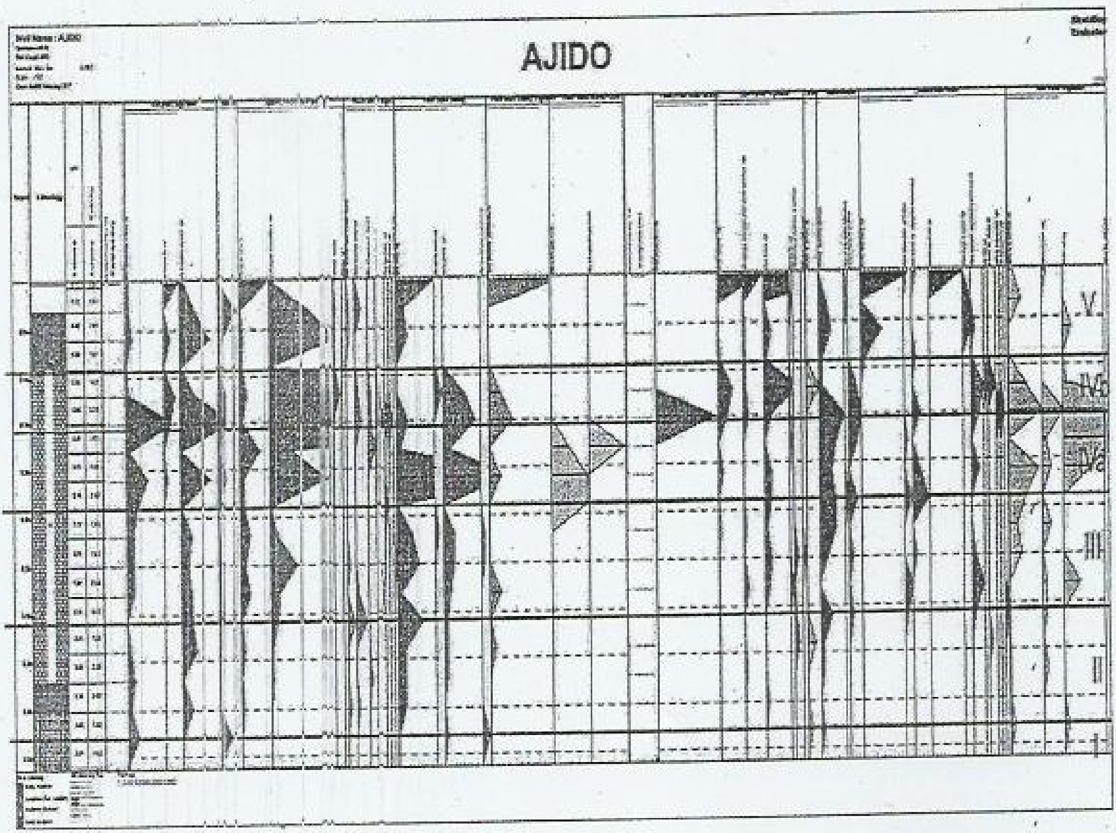

Figure 2 : Pollen Diagram of Ajido Study Location

Six phytoecological groups were recognised based on the present-day distribution of various identified plant taxa, following the works of Hutchinson and Dalziel (1959), Keay *et al.* (1959), Sowunmi (1981, 1987), Poumout (1989) and Durugbo *et al.* (2010).

Five pollen zones were defined based on the distribution of the different taxa, especially the environmental indicators such as mangrove pollen of *Rhizophora* sp., *Avicennia* sp., *Acrostichum aureum, Symphonia globulifera, Amanoa* sp., *Cleistopholis patens*. The zonations of sample depths are highlighted below from the deepest to the topmost section (Figure 2). Dry climate indicators were Poaceae, Acanthaceae, Chenopodiaceae/Amaranthaceae, Asteraceae, *Borerria* sp. Wet climatic indicators are freshwater swamp species including *Spaenoclea* sp, *Laevigatosporites* sp., *Cleistopholis patens, Nymphaea lotus, Symphonia globulifera, Amanoa* sp. and

Pollen zone I (0.51 - 0.475 cm

This is the deepest section of the studied core, characterized by the absence of mangrove *Rhizophora* sp. and *Avicennia* sp. However, spore of brackish water fern *Acrostichum aureum* and fresh water ferns, pollen of *Nymphaea lotus*, *Elaeis guineensis*, other palmae and microforaminiferal wall linings were present in appreciable amounts. The dominantly sandy nature of this section could have affected the preservation of palynomorphs. The assemblage coupled with the presence of microforaminiferal wall linings suggested an incursion of marine water into a near shore environment. A wet/humid climate may be inferred for this zone due to the preponderance of brackish and freshwater elements (Sowunmi, 1999).

Pollen zone II (0.475 - 0.36 cm)

In this zone, a basal sandstone through to upper mudstone intervals were observed with common records of mangrove Rhizophora sp., accompanied by brackish and freshwater swamp species *Acrostichum aureum*, *Symphonia globulifera*, *Laevigatosporites* sp., *Nympheae lotus*, *Sphagnum* sp., *Cyperus* sp., *Lomatia* sp., *Spaenoclea* sp. and spotted occurrences of Poaceae, Chenopodiaceae/Amaranthaceae, *Lomatia* sp, Olacaceae, charred Graminae cuticle, freshwater algae *Pediastrum* sp., the neritic dinoflagellate cyst *Selenopemphix* spp., and the acritarch *Leiosphaeridia* sp. These recoveries were higher in the mudstone interval and this assemblage suggests an incursion of marine water into a near-shore environment of deposition. (See Table 2 and Figure 2 above).

Pollen zone III (0.36 - 0.24 cm

The microflora within this section was characterized by common records of *Laevigatosporites* sp., *Rhizophora* sp., *Acrostichum aureum*, *Cyperus* sp., *Nympheae lotus*, *Symphonia globulifera*, *Sphagnum* sp., *Amanoa* sp., *Lomatia* sp., Poaceae, Chenopodiaceae/Amaranthaceae, *Borreria* sp., *Sphagnum* sp., *Pteris* sp., *Olacaceae* sp., Palmae, charred Graminae cuticle. Freshwater algae *Pediastrum*, spot record of the dinoflagellate cyst *Polysphaeridium zoharyi*, acritarch *Leiosphaeridia* sp. and fungal spores were also recovered. A near shore environment of deposition receiving an influx of marine water is suggested for this zone.

Pollen zone IV (0.24 - 0.09 cm

This dominantly mudstone section produced the richest microfloral assemblage, dominated at lower depths of part of (0.24 m-0.15 m Zone IVa) Figure 2 by moderate records of *Elaeis guineensis*, Poaceae, *Laevigatosporites* spp., *Rhizophora* sp., *Avicennia* sp., *Nymphaea lotus*, *Acrostichum aureum*, *Cyperus* sp., *Amanoa* sp., *Symphonia globulifera*, *Aplanospore* sp., *Ceratopteris* sp., spot occurrence of microforaminiferal wall linings and fungal spores. There was a sharp break at 0.15 m, and a subsequent marked increase in the occurrences of Poaceae and Asteraceae (Zone IVb) at upper depths. These recoveries coupled with spotted records of the dinoflagellate cysts *Spiniferites* sp., *Polysphaeridium zoharyi* and the acritarch *Leiosphaeridia* sp., were indicative of lowered sea levels resulting from a dry climate, especially at the upper depths of this section (Mozardec-Kerfourn, 1992 ; Durugbo *et al.*, 2010).

Pollen zone V (0.09 - 0.00 ml)

This was the uppermost section of the core and composed of sandy mudstones. It yielded common records of *Laevigatosporites* spp., *Rhizophora* spp., *Avicennia* sp., *Cyperus* sp., Acanthaceae, Poaceae, Euphorbiaceae, *Sphagnum* sp. but lacked *Nymphaea lotus*, especially between (0.09 m-0.03 m). This was followed by a marked increase in diversity of the microflora with common records of Poaceae, *Elaeis guineensis*, Symphonia globulifera, Chenopod/Amaranth, Asteraceae, *Borreria* sp., Olacaceae, *Amanoa* sp., *Pteris* sp. (Table 2 and Figure 2). The assemblage within this section suggests an environment that fluctuated between a dominantly wet to dry climate due to a marked increase in the occurrence of dry climatic indicators between 0.03 m - 0.00

m. However, the occurrence of microforaminiferal wall linings and spot occurrence of the neritic dinoflagellate cyst *Selenopemphix* sp. indicates a sedimentary deposition in a near-shore marine environment (Harland, 1983).

Paleoclimatic inferences

Generally, the climate was dominantly humid due to the preponderance of mangrove, freshwater swamp species, brackish water swamp species and Palmae. However, there were dry periods sandwiched in-between (Poumot, 1989; Oboh-Ikuenobe *et al.*, 1992; Morley, 1995 ; Durugbo *et al.*, 2010). The paleoclimatic signature inferred between 0.51 m - 0.45 m was due to the absence of mangrove pollen *Rhizophora* sp. and *Avicennia* sp. coupled with the common records of the brackish water fern spore *Acrostichum aureum*, *Spaenoclea* sp., *Nymphaea lotus* and Palmae. The records of mangrove pollen *Rhizophora* sp., *Acrostichum aureum*, *Nymphaea lotus*, *Cyperus* sp. between 0.44 m - 0.39 m denotes a humid climate. Thirdly, sections between 0.39 m-0.25 m were characterized by common occurrences of *Cyperus* sp. and Poaceae with appreciable amount of mangrove pollen *Rhizophora* sp., Palmae spores, denoting a warm-humid climate. Furthermore, depths between 0.24 m - 0.18 m were characterized by common records of *Rhizophora* sp., *Avicennia* sp., *Elaeis guineensis*, Palmae, *Laevigatosporites* spp., *Nymphaea lotus*, *Acrostichum aureum*, Olacaceae, *Cyperus* sp., *Amanoa* sp., *Symphonia globulifera*, *Aphanospore* sp., *Ceratopteris* sp., suggestive of a dominantly wet /humid climate (Poumot, 1989, Durugbo *et al.*, 2010).

Again, the sediments between 0.18 m - 0.09 m were deposited during a prevailing wet/humid climate due to the abundant records of mangrove pollen types, which include *Rhizophora* sp., *Avicennia* sp., coupled with *Elaeis guineensis*. Sowunmi (1987) noted that earlier association of pollen of *Elaeis guineensis* (oil palm) with wet climatic condition was influenced by the proliferation and association of other Palmae pollen as well as *Laevigatosporites* sp., *Nymphaea lotus*, *Symphonia globulifera* and *Acrostichum aureum*, which are a representation of wet environments. The low to moderate occurrences of Poaceae, Asteraceae and Chenopodiaceae/Amaranthaceae within this interval was noteworthy and denotes a warm-humid climate. The microfloral assemblage between 0.09 m - 0.00 m consists of mangrove pollen and fern spores, coupled with the occurrences of Poaceae, Acanthaceae, Asteraceae and Chenopodiaceae/Amaranthaceae, indicative of a warm-humid climate.

CONCLUSION

The shift between wet-dry paleoclimatic conditions of this area has been revealed in this study. The parent plants of the recovered fossil palynomorphs are still in existence till today. This lends credence to their sustainability, despite the insatiable human-induced activities over time, especially during the late Holocene. As mangrove and fresh water ecosystems are continually depleted, especially by anthropogenic activities in Lagos, Nigeria. It is therefore expedient to further employ conservation strategies in order to avoid their absolute extinction in our environment and save them for future generations.

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