PALYNOLOGICAL SURVEY OF AIR-BORNE POLLEN AND SPORES IN THE UNIVERSITY OF LAGOS, AKOKA CAMPUS, SOUTHWESTERN NIGERIA

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ABSTRACT

Aeropalynological study was conducted in three different locations in the University of Lagos, Akoka campus from the month of April to June 2014. This project aims at surveying the abundance of air-borne palynomorphs and their variation with time. Pollen traps were constructed using buckets, filled with a mixture of 50 ml of glycerol, 10 ml of formaldehyde and 5 ml of phenol and they were placed at the various studied locations, namely Faculty of Science, Senate building and New Hall. The mixtures were collected at the end of every month throughout the sampling period, analyzed and observed under the microscope. The recovered palynological assemblage showed a total abundance of 1,229, 833 and 1,433 palynomorph species in the months of April, May and June respectively. The highest abundance of palynomorphs was recorded in April, June and May at the Faculty of Science, Senate Building and New Hall respectively. A total of 3,495 palynomorphs belonging to about 22 families were recovered in all. The Poaceae family dominates representing 13.67 % of the total palynomorph count, followed by Cyperaceae (12.72 %) Euphorbiaceae (5.34 %) Mimosaceae (8.89 %), Fern spores (8.64 %) and Arecaceae (5.85 %).

Key words: Aeropalynology, Palynomorphs, University of Lagos, Southwest

INTRODUCTION

Aeropalynology is the scientific study of biological particles such as pollen, fungal spores, dust mites, insect debris and organic dust present in the air (Hyde, 1972). Another point of interest is the discovery that certain taxa caused allergic reactions in some people. Therefore, the knowledge of the kind and type of pollen or spores in the air or sample has medical implications. Agwu and Osibe, (1992) studied the release, dissemination, deposition and allergic effects of pollen grains and spores present in the air and Muller (1959) remarked that the transport of these pollen and spores from one area to the other is climatically controlled by the wind strength and direction as well as rainfall.

It has been well established for more than a century that pollen grains are responsible for many allergic diseases, such as hay fever, asthma, allergic rhinitis, and atopic dermatitis (Knox, 1993; Agashe, 1994). Aeropalynological studies have also revealed the effects of rainfall, humidity, temperature, wind speed and direction on the relative concentration of palynomorphs in the atmosphere (Agwu and Osibe, 1992; Agwu, 1997). Airborne fungal spores are minute, unicellular or multicellular reproductive bodies released into the atmosphere mostly by the action of winds and raindrops. They are among the most abundant and least well known of airborne allergens. Many fungi depend exclusively on wind regime for the release and dispersal of their spores. This makes it vital to study the seasonal and diurnal periodicities of these airborne fungal spores over a given period (Njokuocha and Osayi, 2005). Furthermore, not much has been done on the study of air borne pollen and spores in Nigeria and Africa at large. Apart from the published works of Adekanmbi and Ogundipe (2010), Adeonipekun and John (2011), Adeonipekun (2012) in the southwestern Nigeria, Essien *et al.* (2013), Breman (2007) in South Africa and recently Adeniyi *et al.* (2014), there are limited works in this area to serve as a basis for aeropalynological studies.

The type and quantity of airborne palynomorphs at any point in time depends on a number of factors such as atmospheric humidity, rainfall, temperature, wind velocity and direction. According to Essien and Agwu (2013), the wind disseminate freshly released palynomorphs based on seasonal fluctuating direction and strength, in particular it is important to choose a good time frame for aeropalynological studies especially in

periods of maximum production of palynomorphs and optimal wind action. Hence, this study is aimed at determining the abundance and distribution of air-borne palynomorphs suspended in the atmosphere of the study environment as well as correlating the concentration of palynomorphs to the meteorological data prevalent in the study area within the sampling period of April to June, 2014.

MATERIALS AND METHODS

Study Area

The study was carried out in the University of Lagos, Akoka campus Lagos located in the center of the commercial city of Nigeria in tropical West Africa. Three points within the campus were sampled namely: Faculty of science (latitude 6.515599°N and longitude 3.308713°E), Senate building (latitude 6.519819°N and longitude 3.398811°E) and New hall (latitude 6.519325°N and longitude 3.392132°E). The study area has a humid climate characterized by distinct dry and wet seasons with moderate mean annual rainfall which varies between 1381.7 mm and 2733.4 mm. Lagos State has two discernible seasons (rainy and dry seasons) but there is hardly a month without precipitation in any part of the state. A double maxima of rainfall regime are recognizable from March to early July and the other from September to early November with a break in late July and August usually referred to as "August break". The relative humidity is generally high and rarely low throughout the year.

The site sampled falls within the low-lying coastal zone with mangroves lining the brackish lagoons and creeks, while swamp forest grows where the water is fresh and surrounded in places by tropical forest and agricultural lands. Temperatures are high throughout the year, averaging from 23 °C to 35 °C and characterized by secondary growth with very little or no vegetation remaining in their natural virgin state due to developmental projects.

Sample Collection

Improvised pollen traps (Modified Tauber Sampler) were buried in the ground in such a way that the collar was left meters above the ground level according to the method of Tauber (1974) and adapted after Agwu (1992). The improvised pollen trap (buckets) were 25 cm high and 17 cm wide. The instrument, made of aluminum with a 5 cm aperture lid lined with a metal wire mesh was used to trap palynomorphs in three locations - Faculty of Science, Senate building and New hall. The set up was placed at a height of 12 m above ground level and was wedged round to prevent being carried away by wind. A mixture of 50 ml of glycerol, 10 ml of formaldehyde and 5 ml of phenol was poured into the improvised sampling buckets and placed in all the three locations. The pollen trap was changed on the first day of every month throughout the sampling period and taken to the Paleaobotany and Palynology Laboratory; University of Lagos, Nigeria. The sampling process was repeated for three consecutive months: April, May and June 2014.

The samples were centrifuged and washed with distilled water and poured into labelled 10 ml graduated centrifuge tubes according to each month collection, they were centrifuged again at 2,500 rpm and decanted into fresh labelled test tubes and were acetolysed following Erdtman, (1966), Faegri and Iversen (1989) techniques. This treatment was carried out to make the exine structures of the pollen and spores more translucent by destroying the cellulosic materials. Acetolysis mixture is the addition of one part of concentrated H_2SO_4 to nine parts of acetic anhydride. The mixture was prepared by adding 3 ml of concentrated H_2SO_4 to 27 ml of acetic anhydride in a 50 ml measuring cylinder and pipetted into test tubes. The contents were then boiled in a water bath at 100^0C for 5minutes and the residues were stirred occasionally with glass rods. The test tubes were removed from the water bath, allowed to cool then later transferred into another set of well labelled test tubes and centrifuged at 2,500rpm for 5 minutes. Afterwards, the supernatant was decanted off and distilled water was added to each tube and centrifuged again at 2,500 rpm for 5 minutes, this was done till traces of the acetolysis mixture was gone. The supernatant of each test tube was decanted off and the residues were stored in vials bottles and labelled according to location and month of collection. (Erdtrnan 1966).

Three drops of the prepared residue was pipetted gently onto a 22 x 32 mm labelled microscopic slide with glycerin jelly using a micropipette. Care

was taken to ensure even distribution of the residue and a 22 x 22 mm size cover slip was then lowered gently onto the residue in a manner that air bubbles were disallowed. Nail polish was used to hold it firmly on the slide. The prepared slides were studied quantitatively and qualitatively using an Olympus light microscope under (X40 objective lens).

Photomicrographs of recovered palynomorphs were taken using a Euromex 5000 camera mounted on the Olympus microscope at a magnification of X400. Recovered palynomorphs were identified using current and past works of Adekanmbi and Ogundipe (2010), Adeonipekun and John (2011), Adeonipekun (2012), Agwu and Osibe (1992), Agwu (2004), Sowunmi (1973) and Sowunmi (1995). Meteorological data were obtained from the Nigerian Meteorological Agency. The percentage abundance of each species was calculated and monthly pollen concentrations were compared with meteorological data following Mullins and Emberlin (1997), Anderson (1980) and Altinta *et al.,* (2004).

RESULTS

A total of 3,495 palynomorphs were recovered from the three sampled sites belonging to about 22 families. Through the three consecutive months, a total of 1,361 palynomorphs were recovered from Faculty of Science, 986 palynomorphs from Senate Building and 1,148 palynomorphs from New Hall (Figure 1 and Tables 1, 2 and 3). Some pollen could only be identified to their family level while other pollen and spores that could not be identified were also accounted for. Table 1 shows the total pollen count for the Faculty of Science throughout the three months sampling period with the family Poaceae having the highest pollen abundance (13.67%), followed by species of *Cyperaceae* and *Sapotaceae* with abundances of 2.49% and 2.42% respectively. Table 2 shows the total pollen count for Senate Building with family Poaceae having the highest pollen abundance (13.48%), followed by species of Combretaceae and Polypodiaceae with 1.77% and 1.28% respectively. Table 3 shows the total pollen count for New Hall through the same period and Poaceae still dominating with (13.76%), followed by species of *Adiantaceae* and *Euphorbiaceae* with 2.79% and 1.39% respectively. Some of the palynomorphs recovered were identified to the species level such as *Alchornea cordifolia, Acrostichum aureum, Elaeis guineensis, Syzygium guineense* and *Terminalia catappa*. Others were identified to the family level. These include the family: Poaceae, Adiantaceae, Asteraceae, Arecaceae, Annonaceae, Caesalpiniaceae, Cyperaceae, Combretaceae, Chenopodiaceae/Amaranthaceae, Euphorbiaceae, Mimosaceae, Malvaceae, Nymphaceae, Polypodiaceae, Rhizophoraceae, and Sapotaceae. Plates 1-3 show the photomicrographs of the recovered palynomorphs from the three sample locations.

Table 1: Percentage Composition of Total Pollen Counts from Faculty of Science

FAMILY	MEAN POLLEN COUNTS AT DIFFERENT PERIODS				
	April	May	June	Total	Percentage composition
Adiantaceae	5	-	1	6	0.44
Anacardiaceae	1	-	1	2	0.14
Annonaceae	3	-	-	3	0.22
Apocynaceae	15	12	5	32	2.35
Arecaceae	3	4	-	7	0.51
Arecaceae	3	2	1	6	0.44
Asteraceae	10	3	1	14	1.02
Burseraceae	4	1	1	6	0.44
Caesalpiniaceae	2	-	1	3	0.22
Chenopodiaceae / Amaranthaceae	15	1	2	18	1.32
Combretaceae	4	1	2	7	0.51
Cyperaceae	26	7	1	34	2.49
Euphorbiaceae	15	1	4	20	1.46
Fabaceae	3	1	-	4	0.29
Meliaceae	1	1	1	3	0.22
Mimosaceae	3	10	2	15	1.10
Nymphaceae	18	1	1	20	1.46
Onagraceae	10	-	-	10	0.73
Poaceae	116	24	46	186	13.67
Polypodiaceae	3	1	-	4	0.29
Rhizophoraceae	25	1	3	29	2.13
Rutaceae	18	1	3	22	1.61
Sapotaceae	32	-	1	33	2.42
Tricolporate grain	1	3	2	6	0.44
Pollen indeterminate	25	8	3	36	2.64
Trilet spore	2	1	-	3	0.22
Fungal spores Alternaria	20	5	28	53	3.89
Curvularia	2	13	32	47	3.45
Torula spp	-	15	17	32	2.35
Nigrosporia	30	48	44	122	8.96
Hemithosporium	7	1	-	8	0.58
Pithomyces	5	8	19	32	2.35
Fungal spore	156	52	192	400	29.4
Diatoms Aulacosiera	-	3	10	13	0.96
Diatoms	3	19	33	55	4.04
Spore indeterminate	16	25	29	70	5.14
TOTAL	602	273	486	1361	100

Table 2: Percentage Composition of Total Pollen Counts from Senate Building

Family		MEAN POLLEN COUNTS AT DIFFERENT PERIODS				
		April	May	June	Total	Percentage composition
Nigrospora		-	1	-	1	0.09
Hemithosporium		3	1	1	5	0.49
Pithomyces		1	-	-	1	0.09
Apocynaceae		3	1	1	5	0.49
Arecaceae		2	2	-	4	0.38
Asteraceae		-	1	2	3	0.29
Burseraceae		1	-	-	1	0.09
Caesalpiniaceae		-	-	1	1	0.09
Chenopodiaceae / Amaranthaceae		1	2	2	5	0.49
Combretaceae		3	17	-	20	1.96
Cyperaceae		2	4	7	13	1.27
Euphorbiaceae		2	3	1	6	0.59
Fabaceae		1	-	-	1	0.09
Meliaceae		2	-	-	2	0.19
Mimosaceae		1	1	-	2	0.19
Nymphaceae		-	1	1	2	0.19
Onagraceae		1	-	-	1	0.09
Poaceae		11	64	62	137	13.5
Polypodiaceae		2	4	7	13	1.27
Rhizophoraceae		4	-	1	5	0.49
Rutaceae		2	-	2	4	0.39
Sapotaceae		5	-	1	6	0.59
Tricolporate grain		1	3	2	6	0.59
Pteridophyte spore		16	11	9	36	3.54
Pollen indeterminate		1	-	-	1	0.09
Trilete spore		-	-	6	6	0.59
	Alternaria	3	6	16	25	2.46
	Curvularia	1	4	11	16	1.57
Fungal Spore	*Torula spp*	2	6	13	21	2.06
	Nigrosporia	39	59	62	160	15.7
	Hemithosporium	6	-	2	8	0.78
	Pithomyces	-	1	5	6	0.59
Aulacosiera (diatom)		-	2	27	29	2.85
Diatoms		1	16	20	37	3.64
Spore indeterminate		10	9	28	47	4.62
TOTAL		200	264	552	1016	100

TABLE 3: Percentage Composition of Total Pollen Counts from New Hall

FAMILY	MEAN POLLEN COUNTS AT DIFFERENT PERIODS				
	April	May	June	Total	Percentage composition
Adiantaceae	26	5	1	32	2.78
Anacardiaceae	1	-	1	2	0.17
Annonaceae	3	-	-	3	0.26
Apocynaceae	5	1	-	6	0.52
Arecaceae	3	-	-	3	0.261
Arecaceae	2		1	3	0.26
Asteraceae	10	1	1	12	1.04
Burseraceae	1	1	1	3	0.26
Caesalpiniaceae	-	-	1	1	0.08
Chenopodiaceae / Amaranthaceae	9	1	-	10	0.87
Combretaceae	2	-	2	4	0.34
Cyperaceae	1	1	1	3	0.26
Euphorbiaceae	10	1	5	16	1.39
Fabaceae	3	1	-	4	0.35
Meliaceae	-	1	-	1	0.09
Mimosaceae	3	6	-	9	0.78
Nymphaceae	-	1	1	2	0.17
Onagraceae	3	-	-	3	0.26
Poaceae	111	25	22	158	13.8
Polypodiaceae	1	1	-	2	0.17
Rhizophoraceae	11	3	-	14	1.22
Rutaceae	2	-	-	2	0.17
Sapotaceae	2	1	1	4	0.34
Tricolporate grain	3	4	2	9	0.78
Trilete spore	3	-	-	3	0.26
Fungal spore Alternaria	36	3	40	79	6.88
Curvularia	7	11	27	45	3.92
Torula spp	-	19	42	61	5.31
Nigrosporia	22	59	46	127	11.06
Hemithosporium	1	5	4	10	0.87
Pithomyces	9	2	10	21	1.82
Fungal spore	112	88	129	329	28.7
Aulacosiera (diatom)	-	3	14	17	1.48
Diatoms	13	24	29	66	5.74
Spore indeterminate	12	28	44	84	7.32
TOTAL	427	296	425	1148	100

TABLE 4: Meteorological Data Showing Mean Values of Atmospheric Readings in Lagos

PARAMETERS	APRIL	MAY	JUNE
Average Rainfall (mm)	164.8	305.7	295.4
Mean Relative humidity (%)	83	85	87
Mean Temperature (°c)	28.2	27.8	24.9
Mean Wind Speed (km/s)	1.2	0.4	3.9

Source: Nimet, 2014

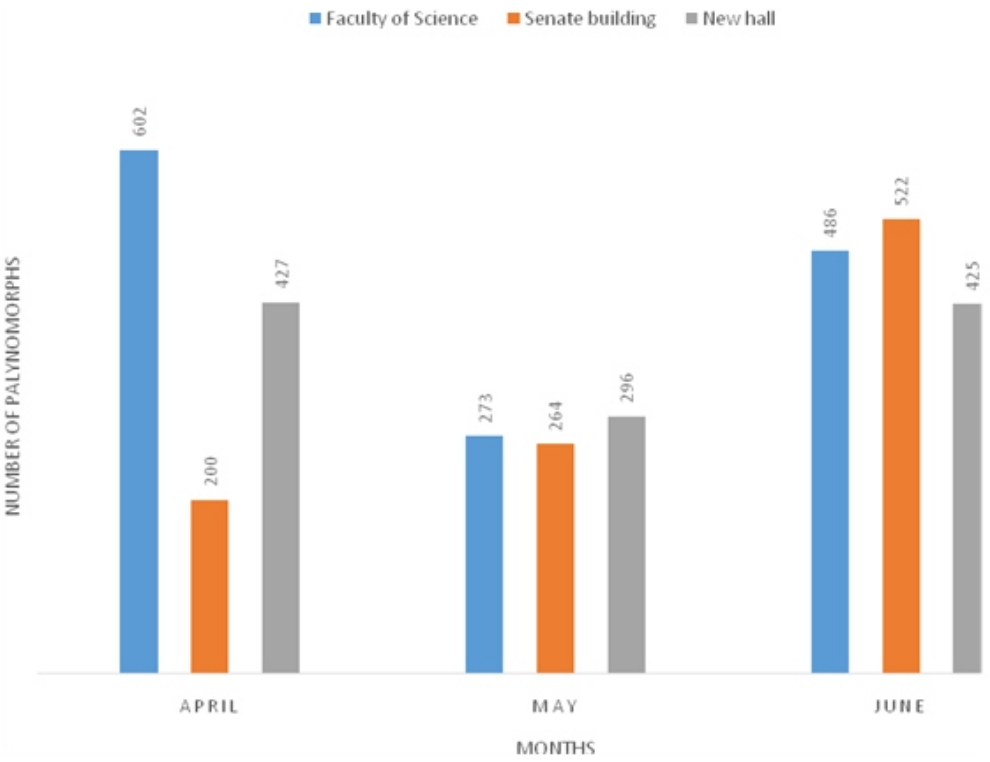


Fig 1: Chart showing the total number of palynomorphs recovered from the three sample sites for the three months.

DISCUSSION AND CONCLUSION

A total of 3,495 of palynomorphs were recovered from the three locations throughout the sampling period. The research yielded a greater recovery of pollens and spores in comparison to the work of Adekanmbi and Ogundipe (2007), where 393 palynomorphs were recovered from four sampling points within the University of Lagos campus. This variation could probably, be due to the difference in the height of the improvised Tauber setup and in placing it 12 m above the ground which permitted the free flow of air and gave the air-borne palynomorphs a higher degree movement, as compared to Adekanmbi and Ogundipe (2010) that was placed on ground. This also relate to the work of Njokuocha (2006), where the total number of palynomorphs within the same duration (April to June) was 2,110 palynomorphs at a height of 15 meters suggesting that, there is a high concentration of palynomorphs in the air.

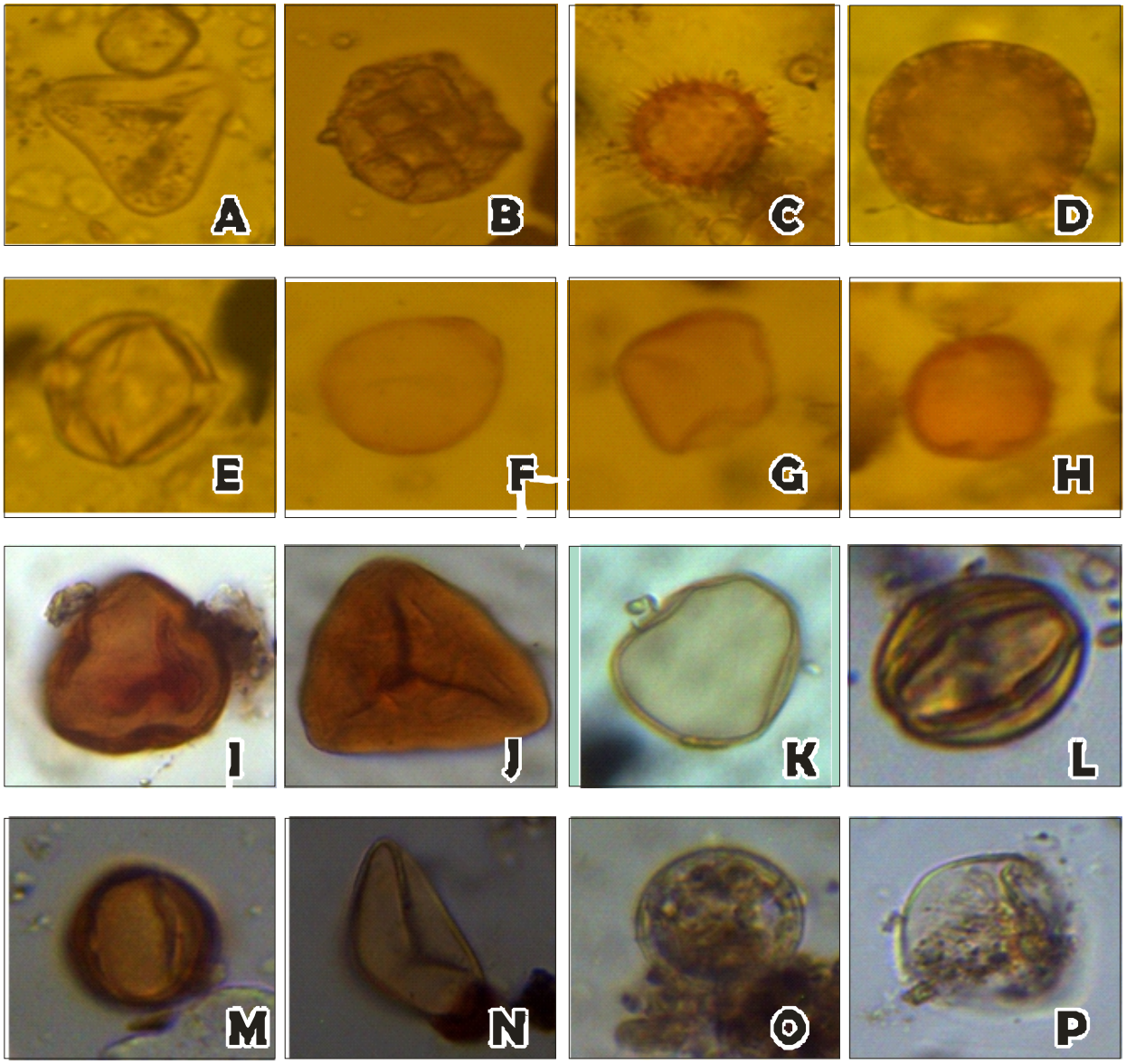
Furthermore, according (Frenze, 2000) airborne pollen and spores concentration exhibit partial variability because pollen from nearby vegetation tends to exert a profound local influence on the recovered palynomorphs. The family Poaceae had the highest abundance throughout the sampling period and this agrees with the work of Adekanmbi and Ogundipe (2010) in the University of Lagos campus where the Poaceae family also had the highest pollen abundance throughout the sampling period. The results coincide with the view of Frenze (2000) who remarked that high incidence of Poaceae, Apocynaceae, Rhizophoraceae, Cyperaceae and Euphorbiacae pollen were probably due to the presence of a large area of parent vegetation in and around the sampling site. The vegetation behind the Faculty of Science is the mangrove vegetation and grasses while Senate building has little or no vegetation due to developmental projects and is surrounded by buildings with patches of grasses, while New Hall has mangrove vegetation and grasses. Faculty of Science had the highest abundance of recovered palynomorphs dominated by Poaceae throughout the sampling period , suggesting an open and dry climate followed by New Hall, which recorded the highest in the month of June. However Senate building recorded the least abundance of recovered palynomorphs, this could probably be

as a result of other buildings around the sampled point which acts as a wind break obstructing the movement of palynomorphs. The recovered pollen grains varied in shapes, sizes, symmetry, type and position of apertures.

The meteorological data showed that, the month of May, had the highest rainfall and elicited the lowest number of palynomorphs. This coincides with the fact that temperature, rainfall, relative humidity and wind speed have direct influence on the concentration of pollen in the atmosphere (Anderson, 1980; Bricchi et al., 1992; Chamberlain and Chardwick, 1972). This influence is reflected in this study, whereby the month of May, had the highest amount of rainfall and the lowest concentration of palynomorphs followed by June and April respectively. Rainfall and relative humidity yield negative correlations since water droplets wash away pollen particles Vega-Maray et al. (2003).

In the month of June, it was observed that the number of palynomorphs from New Hall, increased even with the relatively high humidity and rainfall in that month. This may be due to anthropogenic effects such as construction works going on in the area, which has led to the deforestation of the vegetation around the sampling site. Still in the month of June, it was also observed that the abundance of pollen grains was relatively low in comparison with the abundance of fungal spores recovered from the sampling sites. This also agrees with the study of Njokuocha (2006) which noted that the abundance of pollen in the atmosphere was low but the concentration of spores was high.

The major variation noticed in the monthly pollen counts (of families) and individual pollen types at different sites suggests that the atmospheric concentration of pollen is influenced not only by the meteorological factors, but is essentially a function of the frequency, density and abundance of plant species as well as their flowering behavior at a given locality. This aeropalynological investigation however shows that weather conditions such as temperature, relative humidity, temperature affects the concentration of pollen in the atmosphere and palynomorph load of the locations studied varied quantitatively and qualitatively not only from month to month but also from point to point.



`PLATE 1: Photomicrograph of Recovered Palynomorphs (Pollen)

(A)*Elaeis Guineensis* (B) Mimosaceae Pollen (C) Asteraceae (D) Chenopodiaceae/Amaranthaceae (F-J)*Acrostichum aureum* (H) Rhizophoraceae (I)Cyperaceae (K)*Citrus* spp (M)Meliaceae (E, G, L, T) Pollen indeterminate, (S) Cyperaceae, (Magnification X400)

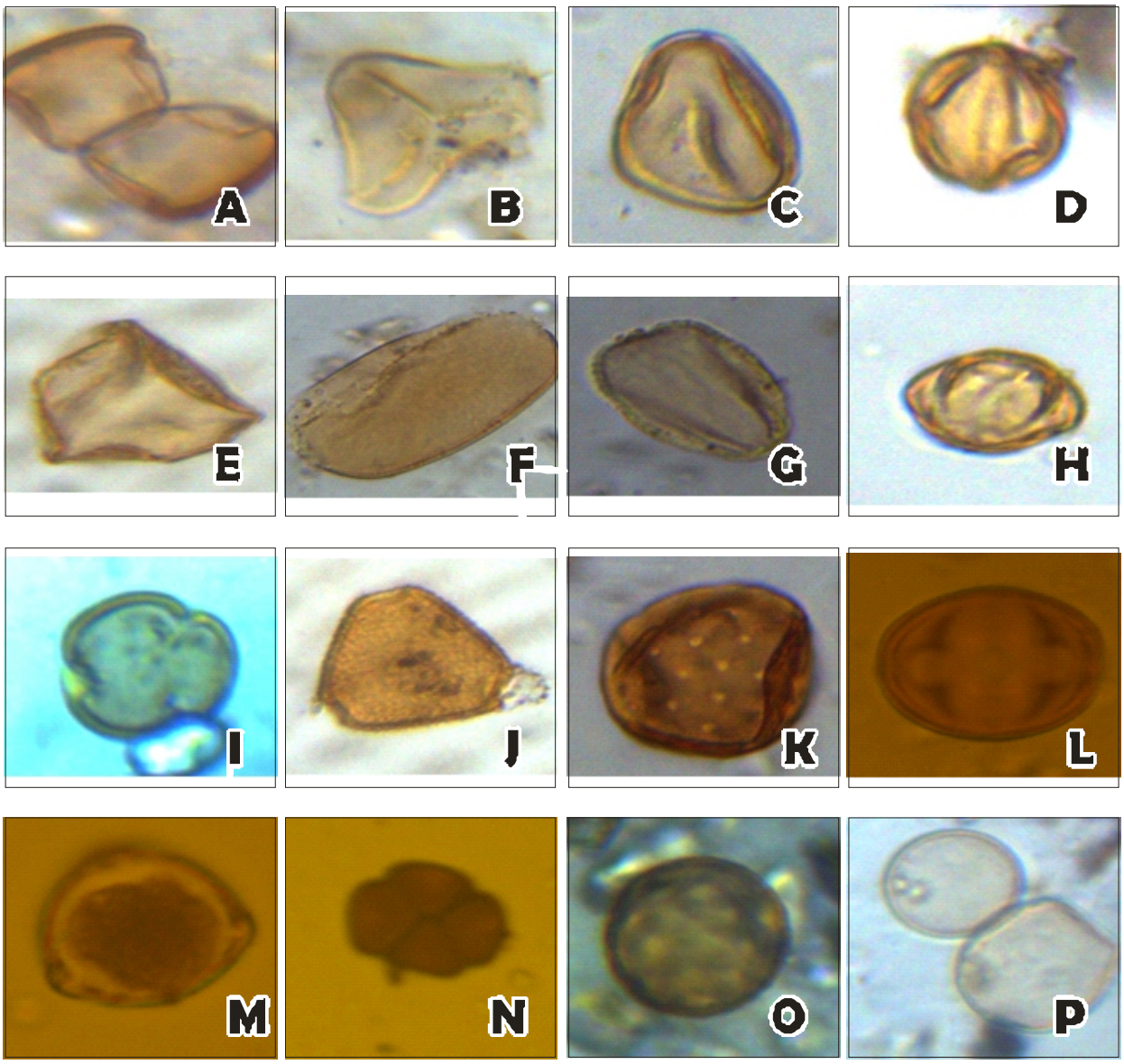


PLATE 2: Photomicrograph of Recovered Palynomorphs (Pollen)

(A) Nymphaceae (B) *Elaeis guineensis* (G,) Cyperaceae (H) Anacardiaceae (I)*Alchornea cordifolia*(K, P) Chenopodiaceae/Amaranthaceae (O) Annonaceae (Q) Poaceae (C, D, E, FJ, L, N) Pollen indeterminate (Magnification X400)

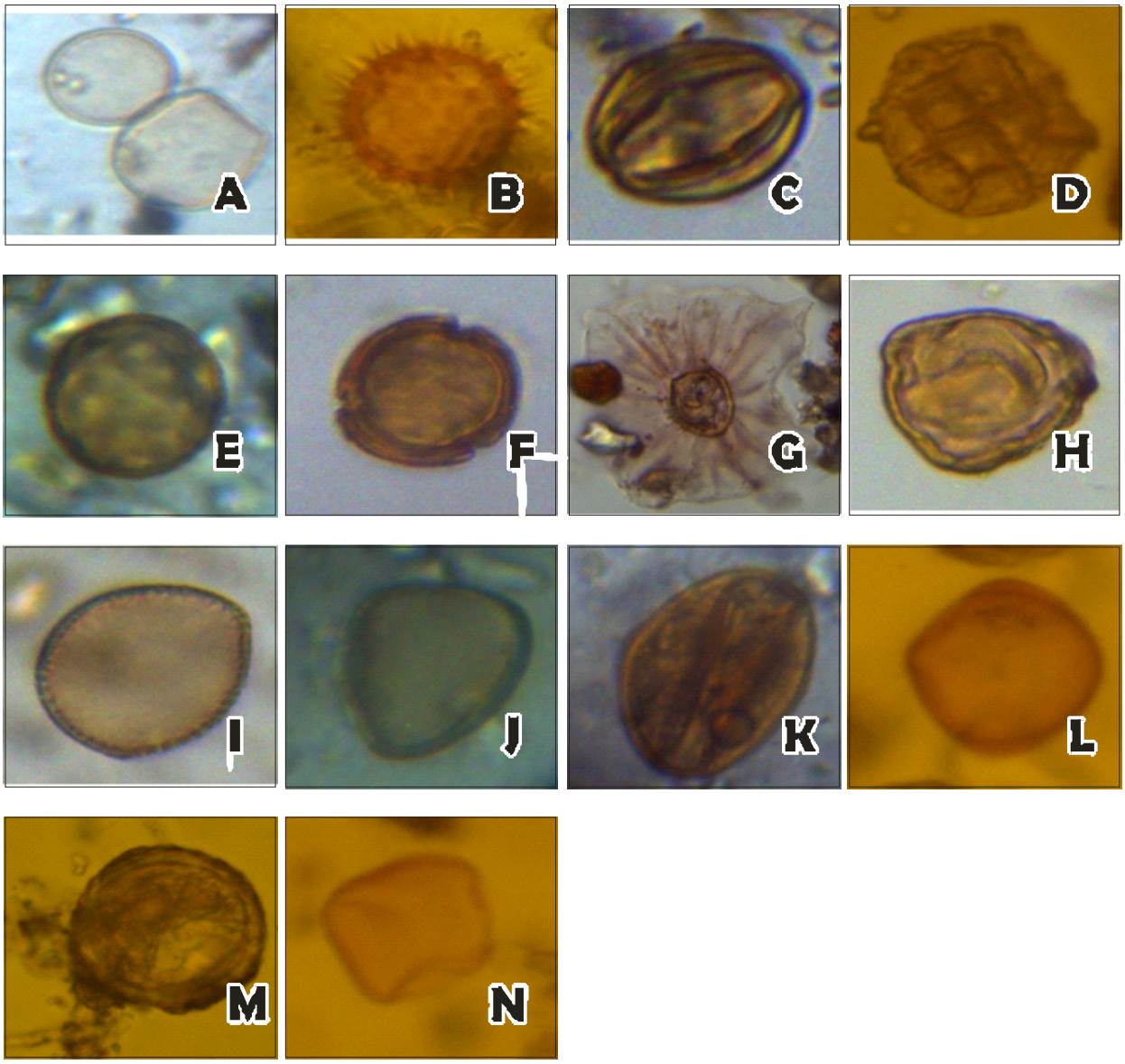


PLATE 3: Photomicrograph of Recovered Palynomorphs (Pollen)

(A) Poaceae (B) Asteraceae (D, N) Mimosaceae (E) Chenopodiaceae/Amaranthaceae (F)*Alchornea cordifolia* (H, J) Citrus spp.(I) Annonaceae (K) Caesalpiniaceae (C,G L) Pollen indeterminate (Magnification: X400)

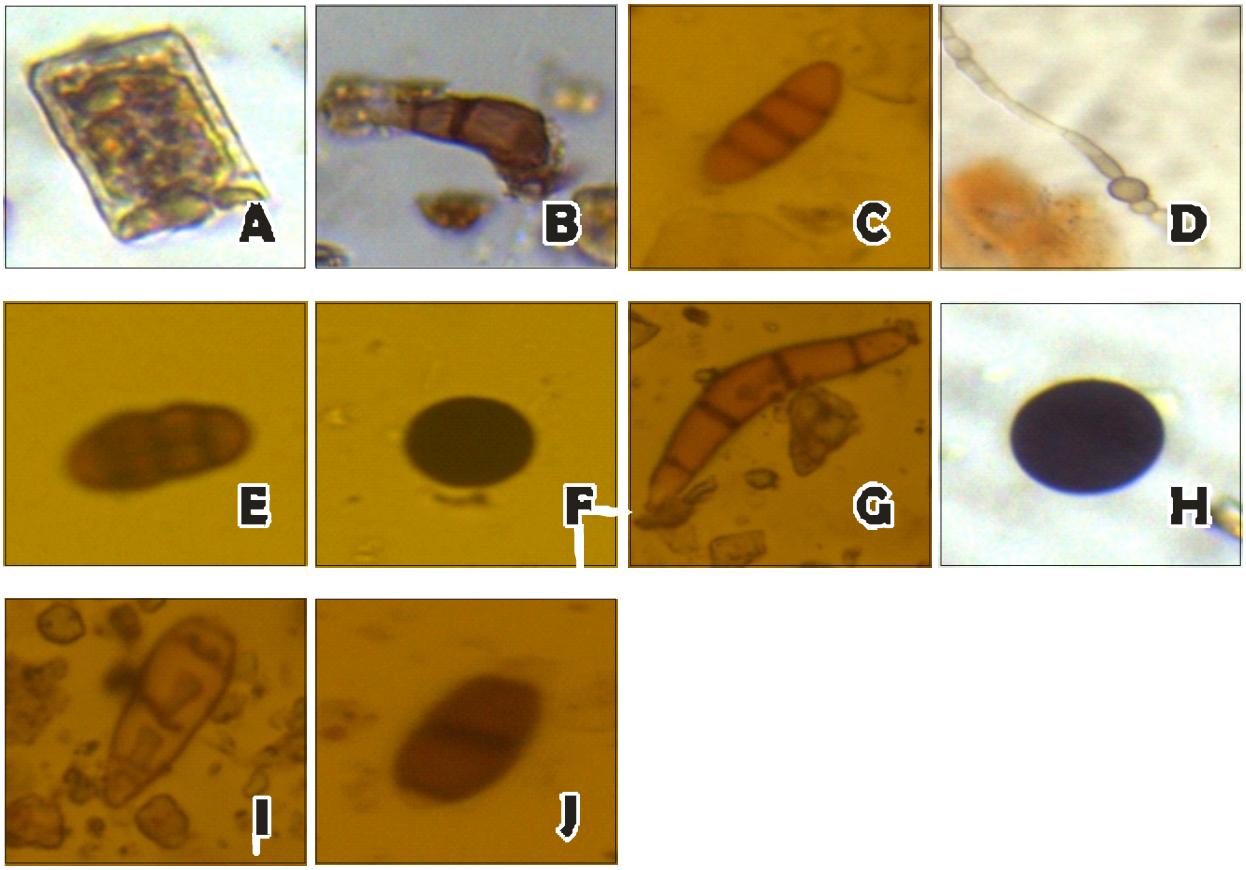


PLATE 1: Photomicrograph of Recovered Palynomorphs (Fungal Spores)

(A) Diatom (B) *Curvularia* (C) Fungal Spore (D) *Torulla* spp (Fungal Spore) (E) Nigrospora spp (Fungal Spore) (F) *Pithomyces* (Fungal Spore) (G) *Curvularia* (fungal spore) (H) *Nigrospora* (fungal spore), (I) Alternaria (fungal spore) (J) Fungal spore (Magnification: X400)

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