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Research Article

Environmental impact analysis through aeropalynology, Kogi State, Nigeria

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Abstract

Airborne bioparticles of Anyigba environment, Dekina Local Government Area, Kogi State, Nigeria were acetolysed and analysed palynologically to determine the taxa of biological importancs present in the atmosphere. A total of three hundred and eight (308) pteridophyte spores, two hundred and thirty eight (238) diatoms, sixty (60) dinoflagellate cysts, sixty six (66) algal cysts, one thousand five hundred and thirty three (1533) charred Poaceae cuticle/ trichomes, three thousand three hundred and seventy one (3371) burnt plant epidermis and three hundred and twenty four (324) insects/ insect parts were documented. The excessive increase in the relative abundance of burnt plant parts is an indication of annual bush fire and residual precipitation associated with the vegetation of the study area. The presence of burnt plant parts and fungal spores in the atmosphere from aesthetic plants affirms the great influence of anthropogenic activities on the local vegetation. Analysis of variance for the various airborne bioparticles showed that there was no significant difference (P>0.05) between the various groups. This study would provide a good template which could be used to monitor the frequency and intensity of indiscriminate bush fire in the surrounding savanna vegetation and provide adequate restoration and conservation measures for safety health and environmental sustainability.

Keywords: Airborne, Bioparticles, Taxa, Palynological, Ecovegetational, Anyigba Environment.

INTRODUCTION

Aeropalynology involves the study of the release, dissemination, deposition and allergic effects of pollen grains, spores and other palynomorphs present in the air (Essien and Agwu, 2013). Aerobiology is a branch of biology that studies organic particles such as bacteria, fungal spores, very small insect and pollen which are passively transported by air (Spieksman, 1991). One of the main fields of aerobiology has traditionally been to measure and report quantities of airborne particles as a service to allergy sufferers (Larsson, 1993). Fungal spores are cosmopolitan in distribution and constitute a large proportion of the airborne palynomorphs trapped in most aeropalynological studies (Njokuocha and Ukeje, 2006). Fungal spores are of particular interest because of their association with plant diseases and pollinosis in man. Although fungal spores are widely distributed in the atmosphere, investigation shows that they are widely modulated by the prevailing weather condition (Calleja *et al*., 1993). The use of spores in environmental studies is primarily in its application to the study of vegetational history. Conclusion about climate and human disturbances could be deduced from from such analysis and these are termed secondary deductions (Erdtman, 1969; Faegri and Iversen, 1989). Facts gathered from such analysis could be useful to climatologists and oil explorationists among others (Moore and Webb, 1983).

Dinoflagellate cysts first appear abundantly and very recognizable in palaeo-palynological preparations of marine sediments in late Triassic. In the Jurassic, they are very abundant and very fast evolving making them ideal subjects for

palynostratigraphy (Traverse, 1988). Diatoms are unicellular algae with a unique silica shell or frustule, which is readily preserved in sediments. Diatom frustules are often abundant and well represented and preserved in palynological preparations (Adekanmbi and Sowunmi, 2007).The report of a comprehensive and elaborate environmental analysis of this nature in Anyigba environment is almost non- existing.
The study is aimed at determining the impact and effect of anthropogenic activities in Anyigba environment.

Present climate

Anyigba, Dekina Local Government Area of Kogi State, Nigeria is endowed with a hot and humid climate. The climate is characterized by the seasonal alternation of the Tropical Continental (TC) and Tropical Maritime (TM) air masses and all year round high temperatures with an annual range of 24.1˚-31.2˚C. Associated with the Tropical continental air mass is the North-East Trade wind (Harmattan), which is prevalent at the beginning (November-January) of the dry season. The South West monsoon wind is associated with the Tropical maritime air mass during the rainy season.

Anyigba (Derived Savanna) environment experiences a fairly distinct rainy season (April‘3.7mm’ – October ‘4.3mm’) and sometimes very little residual precipitation or occasional rainfall in November (1.2mm). Some months of the year (December- March) are completely devoid of rainfall. Similar finding has been reported by Hooghiemstra and Agwu (1986) that the determinant climatic factor is the seasonal distribution of rainfall. The inter-tropical Discontinuity (Inter-Tropical Convergence Zone) is of paramount importance in the distribution of rainfall and pollen rain in West Africa. Wind speed for the study environment is high with a range of 3.6- 4.7Km/hr. Wind speed is critical in the removal of pollen from the anthers of both wind and insect pollinated plants (Essien *et al*., 2013a).

The Study Area

Anyigba, Dekina Local Government Area (LGA) is a university sub-urban town located in the Eastern Senatorial District of Kogi State, Nigeria. Anyigba lies approximately between latitude $7^{0}30^{1}$N and longitude $7^{0}15^{1}$E. It is surrounded by smaller towns, villages and homesteads, whose inhabitants in numerous ways have left their impact on the environment. Map of the study area is shown in Figure 1 below.

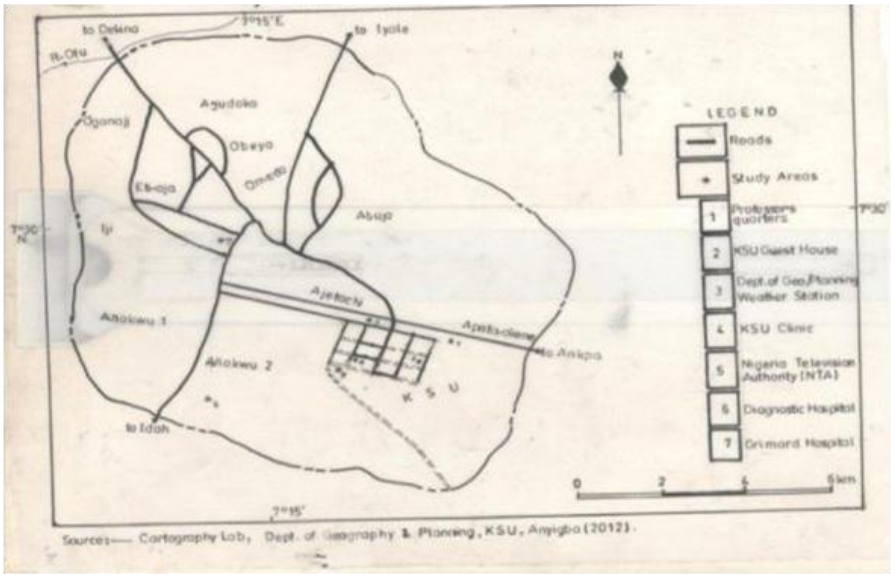

Figure 1. Map of the study area

MATERIALS AND METHODS

Study Design and Sampling Techniques

Eight locations were selected within Anyigba, Dekina Local Government Area of Kogi State, Nigeria as sampling sites. These sites were chosen for safety and security, logistic reasons and convenience of environmental analysis. At each

site, a pollen trap (Modified Tauber Sampler) was buried in the ground in such a way that the collar was about 4cm above the ground level (Tauber, 1977). Prior to this, a mixture of glycerol (65ml), formalin (30ml) and phenol (5ml) was poured into each of the trap. The positions of the traps at various locations were recorded using a Global Position System (GPS). The solutions in the trap prevented the bioparticles from drying up, kill insects and also prevented the decay of dead organisms. The trap was left to stand throughout the duration of the study period. At the end of every two weeks of each month, solution collection was done and the traps thoroughly washed with water to prevent any contamination and are then recharged with the above mentioned chemical solution. This procedure was repeated bi-monthly from March- December (covering both the dry season sampling and the rainy seasons) for one year.

The periodic one year bioparticles collected with the pollen samplers were recovered through centrifugation at 2000 r.p.m (revolution per minute) for 5 minutes and supernatant decanted each time. The precipitates were washed twice with distilled water and recovered through centrifugation. The sediments were treated with glacial acetic acid to remove water before acetolysis. Acetolysis mixture was freshly prepared in a ratio of 9:1 from acetic anhydride and concentrated sulphuric acid. Acetolysis was carried out by boiling the bioparticles in a water bath at 100^0C (Erdtman, 1969; Agwu and Akanbi, 1985). The mixture was placed in water–bath at 100˚C for 5 minutes, stirred and then centrifuged for 5 minutes and supernatant decanted. The recovered precipitates were washed recorded with glacial acetic acid, and finally washed twice with distilled water, centrifuged each time and decanted. The recovered bioparticles were stored in a plastic vials in glycerin and ethanol solution (2:1).

One drop of thoroughly shaken bioparticles suspension was mounted on microscope slide and covered with an 18×18mm cover slip. The mount was sealed off with colourless nail varnish to prevent drying up of the bioparticles. The prepared slide was then examined microscopically with Olympus microscope at x400 magnification for counting and Leica microscope at x1000 magnification for detailed morphological studies. Bioparticles identification, counting and classification was done with the help of reference descriptions and photomicrographs from Agwu and Akanbi (1985); Bonnefille and Riollet (1980) and prepared slides of samples in the Palynological Research Unit; Department of Biological Sciences, Kogi State University, Anyigba.

RESULTS AND DISCUSSIONS

On the basis of aeropalynlogical investigation conducted in Anyigba, Dekina Local Government Area, Kogi State, Nigeria from March to December 2012, a very high concentration of airborne palynomorphs ranging from spores of pteridophytes (ferns), algal cysts, fresh water diatom frustules, dinoflagellate cysts, burnt plant epidermis/ trichomes, charred plant particles, wings of insects/ insect parts, worms and chitinous exoskeleton were documented. Photomicrograph of some of the palynomorphs are shown in figure 2. Previous aeropalynological research carried out in West Africa (Calleja *et al.,* 1993; Melia, 1984; Agwu and Osibe, 1992; Agwu, 1997; Agwu *et al*., 2004, Essien and Agwu, 2013) on the abundance, distribution and diversity of airborne palynomorphs and other particulate entities showed the existence of a large population of diverse organic and inorganic fractions in the atmosphere.

A total of two hundred and thirty eight (238) diatoms were encountered in the study (Table 1). During prolonged dryness in Anyigba environment, ponds and other water logged areas dry up and expose the fresh water algae (diatoms) to strong harmattan winds. The wind waft up the dried mud into the air current (wave) causing an unusual increase in the atmosphere. The increase in fresh water diatom frustules, insect and plant debris in the areospora of Anyigba environment is an indication of increasing dryness and the arrival of long distance transported materials from Northeast (NE) trade wind otherwise known as Harmattan. In environmental analysis, diatoms are useful palaeoecological indicators and have distinct ecological tolerance, and they provide a substantial amount of autecological information.

A total of sixty (60) dinoflagellate cysts (Table 1) were for these taxa. Their rich occurrences and diversity could therefore be linked with the Condensed Sections and associated Maximum Flooding Surfaces (MFS) which occur in River Niger, Lokoja and its environment during the period of the study. Hooghiemstra and Agwu (1986), reported similar finding and opined that dinoflagellates are marine phytoplanktons associated with transgressive and highstand regimes.

Fern spores trapped in this study totaled 308 with a slight increase from March (21) to August (51). During the dry season in Anyigba environment, most ferns and fern- like plants (*Pteris sp., Selaginella and Lycopodium*) die back and survive the inclement period through perennating rhizomes (Essien *et al*., 2013a). The relatively low number of fern spores in the dry season could be attributed to a virtual absence of sporulation of ferns in the dry season (Table 1).

Apart from the regular fungal spores encountered, the study showed that all forms of arthropod particles such as insect and spiders' parts as well as their moults were also trapped in the study. A total of three hundred twenty four (324) arthropod particles (insects/ insect parts) were encountered in the study (Table 1). The presence of some of these organisms or their parts

in the airborne spectrum of Anyigba environment can be interpreted to be vectors of parasites, while their parts are responsible for all forms of allergy when inhaled through the nose as well as exacerbation of asthmatic conditions.

The plant debris recorded were mostly trichomes and epidermal tissue mostly of grasses and some xylem vessel element. A total of 3371burnt plant epidermis/ trichomes were encountered (Table 1). The occurrence and excessive increase in their relative abundance in the airborne spectra of Anyigba environment is an indication of annual bush fire and residual precipitation associated with the vegetation of the study area. The decrease in abundance of burnt plant epidermis/ cuticles from April (324) to October (21) depicts the decrease in available dry leaves especially after bush fire. Results compares favorably with the report of (Essien, *et al*., 2013a) who opined that the presence of burnt plant epidermis/ trichomes in the atmosphere of Anyigba environment affirms the great influence of anthropogenic activities on the local vegetation.

A total of one thousand five hundred and thirty three (1533) charred poaceae cuticles and seven hundred and sixty three (763) johnsons' grass smut were encountered in the study. A reduction in relative abundance of Charred Poaceae Cuticles from April (61) to October (9) depicts the decrease unavailable dry leaves especially after bush fire. During domestic and wild fire incidences, charred plant particles from grasses, shrubs, and trees wafted into the atmosphere. They serve as indicator of bush fire and they can be used in monitoring the intensity and frequency of bush fires. Findings agree favourably with the report of Agwu (2001) who demonstrated the application of 'Charred Graminae Cuticle' as a key identification of late Cenozoic climate changes in the Niger Delta. Although the results showed that the charred plant particles were trapped all through the study period from the atmosphere, higher quantities of these particles were trapped from the period of early to the late dry season (November-52 and May-11) whereas the highest values 1261were trapped in December (Table 1). This could be due to annual bush fires that herald the onset of farming, activities of cattle herdsmen that want to stimulate fresh grass re-growth as well as people that engage in hunting expedition to flush out wild animals (Essien, 2014).

Table 1. Monthly bioparticles record of Anyigba environment

Spores/ Biopaticles trapped	MAR.	APR.	MAY	JUN.	JUL.	AUG.	NOV.	DEC.	TOTAL	MEAN
Algal cysts	13	18	14	10	-	-	11	-	66	8.25
Burnt Plant Epidermis	372	324	172	106	69	21	181	2126	3371	421.375
Charred Poaceae Cuticle	95	61	11	19	25	9	52	1261	1533	191.625
Diatoms	25	52	99	21	-	-	17	24	238	29.75
Dinoflagellate cysts	9	21	11	5	-	-	2	12	60	7.5
Insects/ insect part	63	24	62	11	17	7	10	130	324	40.5
Johnson grass smut	11	3	615	6	-	-	40	88	763	95.375
Pteridophyte spores	21	23	32	47	120	51	14	-	308	38.5
TOTAL TRAP BIOPARTICLE	609	526	1016	225	231	88	327	3641	6663	832.875

PHOTOMICROGRAPHS OF SOME PREDOMINANT PALYNOMORPHS

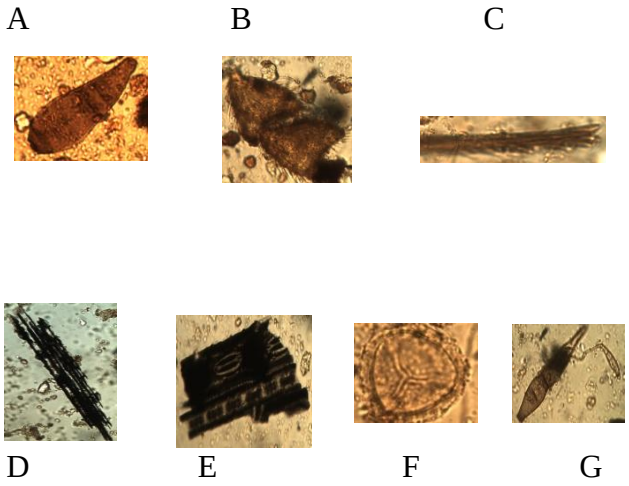

Figure 2. A- Diatoms; B-C: - Insect parts; D- Burnt epidermis; E- Charred cuticle; F-Pteridophyte spore; G- Dinoflagellate cysts.

Analysis of variance for the various airborne bioparticles taxa showed that there was no significant difference (P>0.05) between the various groups.

The epidermis, cuticles and trichomes of burnt plant parts is recognizable and an increase in number in the atmosphere of the study area corresponds to an increase in the incidence of bush fire in the surrounding savanna vegetation. This factor could be used to monitor the frequency and intensity of indiscriminate bush fire. The presence of pteridophyte spores, dinoflagellate cysts and diatom frustule in the atmosphere confirm the great influence of anthropogenic activities on the local vegetation. It is evident to say that several allergic reactions of the eyes resulting in symptoms such as sneezing, runny/ itchy nose as well as itchy and watering eyes prevalent in Anyigba environment recently is as a result of the abundance and prevalence of different species of these aerospora.

CONCLUSION

In conclusion, the results of this study would provide a good template which could be used to monitor the frequency and intensity of indiscriminate bush fire in the surrounding savanna vegetation and provide adequate restoration and conservation measures for safety health and environmental sustainability and has given detailed information on the aerobiology of the Dekina Local Government Area of Kogi State, Nigeria at large.

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