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Research Article

Evaluation of the phytoecological indicator species in the airborne palynomorphs from Anyigba, Kogi State, Nigeria

*[1]Essien BC and [2]Nkang AE

[1]Department of Biological Sciences, Kogi State University, Anyigba, Nigeria
[2]Department of Botany, University of Calabar, Calabar, Nigeria

*Corresponding Author E-mail: **benjaminessien8@gmail.com**

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Abstract

Airborne palynomorphs from eight localities in Anyigba, Kogi State, Nigeria were analyzed palynologicaly for their phytoecological indicator species. A total of fourty-seven (47) pollen type belonging to twenty- nine (29) plant families were encountered. Indicator species identified were those of forest (2378), savanna (6819) and human impact (823) pollen grains. The predominant indicator species were pollen of *Alchornea cordifolia* Sw., *Berlinia grandifolia* (Vahl) Hutch. And Dalz., *Commiphora africana*, *Elaeis guineensis* Jacq., *Nauclea latifolia* Sm., *Lannea acida* A. Rich., *Syzygium guineense*, and members of the families Poaceae, Combretaceae/ Melastomataceae and Asteraceae tubiliflorae complex. Analysis of variance for the various phytoecological indicator species shows that there was no statistical significant difference (P>0.05) between the pollen recorded for the various indicator species. Indicators of Savanna species were the highest pollen contributors. The variation 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. Results confirmed the vegetation of the study area to be Derived Savanna despite high level of anthropogenic activities. The results of this study have shown the various phytoecological indicator species in the study environment; most of which are at the verge of extinction through series of anthropogenic activities. Such plants could be properly conserved and their exploitation managed to prevent extinction thereby enhancing biodiversity sustainability.

Keywords: Phytoecological, Palynological, Airborne Palynomorphs, Indicator species, Kogi, Nigeria

INTRODUCTION

Airborne pollen and spores are indicators of the vegetation of a region and are related to the palynomorphs produced in the immediate surroundings of the study location and catchment area (Agwu, 1997).The study of vegetation and the way in which it has been altered and developed in the course of time indicates past changes that have occurred in our terrestrial environment. Variations in climate and in the intensity of human activity in historic and prehistoric times have made their mark upon vegetation, and the plants themselves have left a record of these changes in the form of vast quantities of pollen grains which have survived in contemporary sediments (Roberts, 1998).

Some plants inhabiting specific environments tend to become genetically adapted to the environmental conditions such that they become more predominant than others (Nnamani and Agwu, 2008). They are generally the most conspicuous and may be indicators of a particular ecological zone. They may be used as standard in identifying similar communities elsewhere. Most ecosystems characteristically possess well defined soil type, microclimate, flora and fauna and have their potential for adaptation, change and tolerance (Ibiam, 2000).

Some plants are habitat specific or are tolerant to a certain ecological site; they are seldom found elsewhere except in areas with the same or related ecological settings. Dieter and Heinz (1974) opined that the decline of such plants as a result of disturbances may alter the ecosystem. These disturbances may result from natural events such as draught, climate changes, volcanic activities, flood, diseases and wind.

The widely dispersed pollen and spores provide a broad picture of the surrounding vegetation of the areas in which they are produced. Some factors that aid in the dispersal are the size, shape and density of the pollen and spores, the position of the parent plants (that produce them) in the vegetation and the prevailing climatic conditions (Agwu, 2001).

The quantity and quality of palynomorphs, especially pollen grains and spores in the air at any given time depend largely on the plant and fungi producing them, the abundance of the plant communities, the nature of palynomorphs, the flowering or season of reproduction and the meteorological factors such as rainfall, humidity, temperature, wind speed and wind direction (Agwu, 2001).

The use of pollen and 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 such analysis and there are termed secondary deductions (Erdtman, 1969). Fact gathered from such analysis could be useful to climatologists and oil explorationists among others (Moore and Webb, 1983). Analysis of fossil pollen is the most important approach to reconstruction of past flora, vegetation and environment (Faegri and Iversen, 1989).

Vegetation is an assemblage of synusia existing together in a particular location that may be characterized by its component species or by combination of structural and functional characters, which characterize the appearance or the physiognomy of the vegetation. This vegetation, though zoned into belts that correspond to the rainfall zones, is still controlled by edaphic, climatic and geomorphological factors (White, 1983).

Derived Savanna is a vegetation type which is characterized by the presence of fire tolerant and fire sensitive trees with appreciable occurrence of grasses and is co-inhabited by forest and savanna species (Usman, 2004).

This study is aimed at identifying the phytoecological indicator species and to determine the vegetation status of the catchment area investigated. The results of this study would provide baseline information on the conservation and sustainable exploitation of these indicator species through appropriate biotechnological measures.

MATERIALS AND METHODS

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 palynomorphs 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 April- December (covering both the dry season sampling and the rainy seasons) for one year.

The periodic one year palynomorphs 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 palynomorphs 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 with glacial acetic acid, and finally washed twice with distilled water, centrifuged each time and decanted. The recovered palynomorphs were stored in a plastic vials in glycerin and ethanol solution (2:1). One drop of thoroughly shaken palynomorphs 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 palynomorphs. 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. Palynomorphs identification, counting and classification was done with the help of reference descriptions and photomicrographs from Agwu and Akanbi (1985); Bonnefille and Riollet (1980);Sowunmi (1978; 1995) and prepared slides of pollen samples in the Palynological Research Unit; Department of Biological Sciences, Kogi State University, Anyigba.

RESULTS

Fourty-seven (47) pollen type belonging to twenty- nine (29) Plant families were encountered. All the plants identified were grouped into different phytoecological indicator species thus: Forest (open forest and lowland rainforest), Savanna and Human impact (Table 1). A total of 10,020 pollen grains were counted. Plants of the forest taxa contributed 2378 pollen grains, savanna 6819 pollen grains and 823 pollen grains coming from human impact taxa (Table 1). Photomicrographs of some of the indicator species were taken (Figure 1).

Table 1. Absolute Pollen Counts for the Phytoecological Indicator Species

POLLEN TYPE	FAMILY	L1	L2	L3	L4	L5	L6	L7	L8	TOTAL
FOREST SPECIES										
Albizzia zygia	***Mimosaceae***	**3**	**3**	**8**	**5**	**2**	**11**	**7**	**12**	**51**
Alchornea cordifolia	***Euphorbiaceae***	**39**	**25**	**42**	**33**	**11**	**14**	**9**	**54**	**227**
Berlinia grandifolia	***Caesalpinaceae***	**31**	**3**	**-**	**27**	**3**	**25**	**11**	**13**	**113**
Bombax buonopozense	***Bombacaceae***	**6**	**3**	**7**	**-**	**-**	**-**	**-**	**10**	**26**
Ceiba pentandra	***Bombacaceae***	**13**	**9**	**6**	**-**	**11**	**-**	**-**	**-**	**39**
Senna sp.	***Mimosaceae***	**-**	**-**	**18**	**5**	**7**	**4**	**12**	**-**	**46**
Celtis sp.	***Ulmaceae***	**13**	**2**	**7**	**-**	**3**	**6**	**9**	**15**	**55**
Commiphora africana	***Burseraceae***	**39**	**37**	**21**	**14**	**8**	**2**	**5**	**12**	**138**
Elaeis guineensis	***Arecaceae***	**363**	**185**	**158**	**105**	**271**	**111**	**44**	**71**	**1308**
Blighia unijugata	***Sapindaceae***	**5**	**-**	**2**	**7**	**-**	**-**	**-**	**-**	**14**
Talinum triangulare	***Portulacaceae***	**-**	**6**	**8**	**11**	**-**	**-**	**4**	**9**	**38**
Newbouldia leavis	***Bignoniaceae***	**19**	**5**	**-**	**10**	**17**	**12**	**-**	**16**	**79**
Merremia sp.	***Convolvulaceae***	**4**	**-**	**2**	**-**	**-**	**-**	**-**	**6**	**12**
Nymphaea sp.	***Nympheaeceae***	**11**	**-**	**6**	**-**	**6**	**5**	**-**	**9**	**37**
Paullinia pinnata	***Sapindaceae***	**13**	**9**	**3**	**-**	**-**	**7**	**-**	**3**	**35**
Polygonum sp.	***Polygonaceae***	**3**	**-**	**4**	**1**	**1**	**-**	**3**	**1**	**13**
Anopyxis sp.	***Rhizophoraceae***	**-**	**5**	**3**	**9**	**6**	**-**	**6**	**12**	**41**
Encephalartos sp.	***Cycadaceae***	**19**	**11**	**13**	**9**	**-**	**10**	**-**	**8**	**70**
Euphorbia hirta	***Euphorbiaceae***	**3**	**5**	**9**	**3**	**4**	**7**	**-**	**5**	**36**
SUB TOTAL		**584**	**308**	**317**	**239**	**350**	**214**	**110**	**256**	**2378**
SAVANNA SPECIES										
Acacia sp.	***Mimosaceae***	**7**	**14**	**3**	**-**	**-**	**-**	**8**	**3**	**35**
Cyperus sp.	***Cyperaceae***	**19**	**7**	**1**	**-**	**3**	**11**	**5**	**6**	**52**
Combretaceae/ Melast.		**78**	**35**	**11**	**31**	**23**	**15**	**29**	**20**	**242**
Mimosa sp.	***Mimosaceae***	**2**	**5**	**-**	**7**	**4**	**-**	**5**	**7**	**30**
Syzygium guineense	***Myrtaceae***	**23**	**11**	**18**	**9**	**14**	**16**	**7**	**3**	**101**
Syzygium sp.	***Myrtaceae***	**-**	**6**	**2**	**5**	**9**	**7**	**11**	**21**	**61**
Daniellia oliveri	***Caesalpinaceae***	**6**	**3**	**8**	**5**	**11**	**-**	**5**	**7**	**45**
Gloriosa superba	***Liliaceae***	**-**	**-**	**5**	**12**	**7**	**3**	**1**	**18**	**46**
Khaya senegalensis	***Meliaceae***	**11**	**7**	**5**	**5**	**-**	**2**	**4**	**-**	**34**
Trichilia prieureana	***Meliaceae***	**3**	**5**	**-**	**5**	**-**	**4**	**-**	**-**	**17**
Nauclea latifolia	***Rubiaceae***	**46**	**-**	**67**	**-**	**28**	**9**	**-**	**18**	**168**
Morelia senegalensis	***Rubiaceae***	**4**	**3**	**-**	**-**	**2**	**2**	**3**	**-**	**14**
Phyllanthus sp.	***Euphorbiaceae***	**7**	**4**	**2**	**5**	**9**	**3**	**3**	**-**	**33**
Hymenocardia acida	***Euphorbiaceae***	**5**	**2**	**2**	**-**	**9**	**3**	**3**	**2**	**26**
Lannea acida	***Anacardiaceae***	**297**	**86**	**158**	**104**	**62**	**74**	**105**	**58**	**944**
Rauvolfia vomitoria	***Apocynaceae***	**3**	**4**	**-**	**-**	**-**	**-**	**-**	**-**	**7**
Poaceae	***Poaceae***	**1481**	**836**	**1005**	**414**	**475**	**214**	**297**	**242**	**4964**
SUB TOTAL		**1992**	**1028**	**1287**	**602**	**656**	**363**	**486**	**405**	**6819**
HUMAN IMPACT SPECIES										
Amaranthaceae/Chenopodiaceae		**11**	**15**	**52**	**18**	**46**	**18**	**12**	**24**	**196**
Asteraceae tubiliflorae		**58**	**75**	**37**	**62**	**27**	**33**	**41**	**29**	**362**
Delonix sp.	***Caesalpinaceae***	**-**	**2**	**3**	**2**	**5**	**1**	**3**	**5**	**21**
Ricinus communis	***Euphorbiaceae***	**6**	**-**	**-**	**5**	**9**	**-**	**-**	**-**	**20**
Solanum melongena	***Solanaceae***	**14**	**8**	**6**	**7**	**23**	**3**	**5**	**10**	**76**
Jatropha sp.	***Euphorbiaceae***	**5**	**6**	**2**	**3**	**6**	**8**	**-**	**-**	**30**
Justicia sp.	***Acanthaceae***	**-**	**-**	**3**	**-**	**27**	**15**	**6**	**11**	**62**
Adenanthera pavonina	***Mimosaceae***	**-**	**6**	**3**	**2**	**8**	**2**	**4**	**-**	**25**
Corylus avellana	***Bertulaceae***	**5**	**-**	**-**	**-**	**-**	**-**	**6**	**8**	**19**
Crescentia sp.	***Bignoniaceae***	**2**	**-**	**3**	**-**	**-**	**-**	**4**	**-**	**9**
Ecbolium sp.	***Acanthaceae***	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**
SUB TOTAL		**101**	**112**	**109**	**99**	**151**	**80**	**81**	**90**	**823**
GRAND TOTAL		**2677**	**1448**	**1713**	**940**	**1157**	**657**	**677**	**751**	**10020**

Photomicrographs of some of the indicator species:

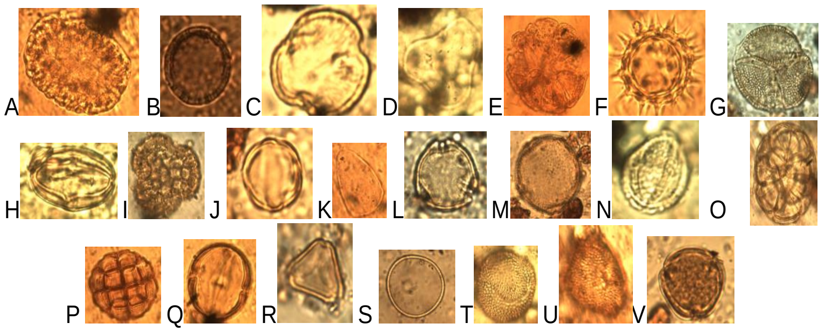

Figure 1. A- *Ecbolium sp.*; **B-***Amaranthaceael Chenopodiaceae*; **C-** *Lannea acida*; **D-***Elaeis guineensis*; **E-** *Rauvolfia vomitoria*; **F-** *Asteraceae*; **G-** *Newbouldia laevis*; **H-***Senna sp.*; **I-** *Delonix sp.*; **J-** *Combretaceael Melastomataceae*; **K-** *Cyperaceae*; **L-** *Alchornea cordifolia*; **M-** *Hymenocardia acida*; **N-** *Phyllanthus sp.*; **O-** *Adenanthera pavonina*; **P-** *Albizzia zygia*; **Q-***Trichilia prieureana*; **R-** *Syzygium guineense*; **S-** *Poaceae*; **T-** *Talinum triangulare*; **U-***Morelia senegalensis*; **V-** *Solanum melongena*;

DISCUSSIONS

Analysis of airborne palynomorphs from Anyigba, Kogi State, Nigeria revealed great diversity of palynomorphs consisting of pollen grains of various indicator species. The investigation showed that there were more of savanna indicators (6819 pollen grains) followed by that of the forest (2378 pollen grains) as compared to the indicators of human impact (823 pollen grains) species. These differences could be attributed to the fact that the study area is located between the true Guinea Savanna in the North and the Tropical Rainforest belt in the South of Nigeria which is otherwise known as the Mosaic of Lowland Rainforest and Secondary Grassland (White, 1983).

Anthropogenic activities and natural events have resulted in varying floral composition of the vegetation in different parts of the study area. Certain areas, particularly gallery forests and windward sides of highland, are populated by forest species while the open areas and senile soils are dominated by savanna species. Other places are more or less shared by both equally. The larger number of plant taxa as shown by the results is a reflection of the floral diversity characteristic of the derived savanna. Findings is in line with the report of Usman (2004) who opined that Derived Savanna is characterized by the presence of fire tolerant and fire sensitive trees with appreciable occurrence of grasses and is co-inhabited by forest and savanna species.

The vegetation of the study area is essentially a Derived Savanna, where Forest and Savanna species co-exist side by side with relics of Forest vegetation disappearing to be succeeded by fire-hardy species of Savanna. Disappearance of Forest species is brought about by a combination of factors, including annual bush-burning, excessive lumbering, excessive firewood gathering, excessive grazing by livestock and shifting cultivation. As a result of these factors, the vegetation of the study area has become impoverished with several economic species at the verge of extinction (Usman, 2012).

In this study, it was found that the pollen load of the entire study area varied quantitatively and qualitatively not only from month-to-month but also from site-to-site. In the same way, atmospheric pollen studies conducted in various parts of the world showed that there were variations not only in monthly pollen concentration, but also site-to-site variations in monthly pollen content of major individual pollen types as regards maximum count (Rogers and Levetin, 1998; Monlina *et al*., 2001; Njokuocha and Ezenwajiaku, 2010). According to Singh and Babu (1981) 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. For instance, in the present study, the higher values of *Elaeis guineensis*, *Lannea acida*, *Poaceae*, *Syzygium guineense*, *Ceiba pentandra*, *Paullinia pinnata*, *Berlinia grandifolia* and *Combretaceael Melastomataceae* pollen grains at location(L1) than at other sites may be largely due to the high density of these plants at these site than are present at other locations. The same explanation is applicable for the pattern of variation observed for other pollen types.

The high occurrence of pollen of the Poaceae family is an indication of the proximity of study area to the fringe of the guinea savanna belt of the core north, as reported by Agwu and Abaeze (1991).Moreso, Poaceae (grass family) pollen was the major contributor to the airborne pollen trapped in this study with a total of 4964 pollen grains. This finding is in line with the results of Njokuocha (1996) who reported that poaceae pollen was the major contributor to the atmospheric pollen content of Nsukka as well as other southeastern states of Nigeria. Anyigba is also known for the cultivation and production of oil palm and palm produce (*Elaeis guineensis*). Its abundance in the pollen spectra of the study area depicts extension of wooded grassland and traditional forest. The presence of pollen record of *Corylus avellana*, *Encephalartos* species and *Ecbolium* species is a valid evidence of long distance transport.

Analysis of variance for the various phytoecological indicator species shows that there was no statistical significant difference (P>0.05) between the pollen recorded for the various indicator species. Indicators of Savanna species were the highest pollen contributors. Results confirmed the vegetation of the study area to be Derived Savanna despite high level of anthropogenic activities.

In conclusion, the results of this study have shown the various phytoecological indicator species in the study environment; most of which are at the verge of extinction through series of anthropogenic activities. Such plants could be properly conserved and their exploitation managed to prevent extinction thereby enhancing biodiversity sustainability.

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