The Study Of Airborne Pollen And Spores Circulating At "Head Level" In Nsukka Environment

C. O. C Agwu[1]., R. C Njokuocha[1] and O. Mezue[2]
[1]Environment and Palynology Research Unit, Department of Botany, University of Nigeria, Nsukka.
[2]Shell Petrochemical Development Cooperation, Warri

Abstract

The quantitative air spora investigation at "head" level in the dry season (November-February) revealed a substantial presence of pollen grains, fungal spores and such other component as fern spores, diatom frustules and plant debris. The trapped pollen grains are representative of trees, shrubs, weeds/herbs and grasses of both indigenous and introduced species. Trees and grasses (Poaceae) contributed 49.07% and 30.91% of total pollen, respectively. The qualitative pollen record indicates that more species of entomophilous plants were dominant in the pollen count, whereas pollen grains of anemophilous plants were found to predominate quantitatively. The most frequent and abundant pollen types include those of Poaceae (grasses), *Elaeis guineensis*, *Casuarina equisetifolia*, *Alchornea cordifolia*, *Milicia excelsa*, and Amaranthaceae / Chenopodiaceae. Fungal spores were found to dominate the entire component of the airborne spora counted. The most common fungal spores encountered include those of *Cladosporium*, *Ustilago*, *Nigrospora*, *Drechslera* /*Helminthosporium* and *Pithomyces*.

Introduction

In recent times, there has been growing awareness on the importance of airborne pollen grains and fungal spores as causative agents of certain allergic discomforts in man and fungal diseases for domestic animals and crops. Particularly, with advances in science, the knowledge of opportunistic fungal infections is now on the increase (Frankland, 1987 and Singh, 1987). Excessive environmental exposure to the fungal pathogens, allergic pollen and spores, and other numerous organic and inorganic particles may be responsible for a variety of allergic symptoms found to be compatible to certain toxic reactions. Some of these symptoms have been reported to be attributable to certain proteins and proteases enzymes present in the allergens and whose sensitizing capacity is capable of eliciting chemically irritant effects, which may destroy the tissue of the bronchial mucosa if inhaled (Gallup, *et al*., 1987 and Royce, 1987).

Most pollen and fungal spores identified from airborne palynomorphs have been widely reported to be allergens of various sensitizations to man and domestic animals as ingestants or skin reactants (Budd, 1986; Frankland, 1987 and Singh, 1987). Such common and predominant fungal spore allergens as *Alternaria*, *Cladosporium*, *Drechslera* / *Helminthosporium*, *Fusarium*, *Penicillium* and *Aspergillus* among others, have been trapped in high quantity in other locations (Vital and Krishnamoorthi, 1981; Hutardo and Riegler–Goihman, 1987; Frankland, 1987 and Njokuocha, 1997). Variations in the periodic occurrence of the allergens in the air have been observed (Spieksma, *et al*., 1985; Agwu and Osibe, 1992; Agwu, 1997 and 2001) and they have been attributed to periods of sporulation and weather variations (Calleja, *et al.*, 1993, Dupont and Agwu, 1991). Khandelwal (1982) and Njokuocha (1997) have also reported the existence of vertical variations in the distribution pattern of pollen grains and spores. These vertical variations in distribution pattern of pollen grains and spores were influenced by interrelated environmental, climatic and biological factors (Street and Hamburger 1976; Agwu and Osibe, 1992; Calleja, *et al*., 1993; Agwu, 1997 and 2001). According to Hooghiemstra *et al*., (1986), the determination of the period of main pollen release and their average atmospheric circulation pattern effective at any given time of the year is of prime importance in aero-studies. Consequently, a good attempt at establishing the identification, peak periods and improvement in the prediction of the allergens may help in unraveling some of the allergic and pathological ailments arising from them.

The analysis of airborne palynomorphs with respect to the present floral community provides leading evidence in the type of environment and the extent of interaction between nature and human activities in the environment (Sugita, 1994 and Agwu, 2001). During the Harmattan season most people suffer more from various forms of allergies arising from contact with or ingestion or inhalation of the airborne spores and other particles which are either refloated from the dusty environment or dispersed freshly from the immediate and distant vegetations. During this period most plants are at the peak of flowering (Keay, *et al.,* 1964 and

Agwu, 1997). Consequently, it is expected that the atmosphere being characterized by pronounced turbulent wind and frequent whirlwinds will be saturated with airborne particles. With the high rising population of the study locality, the airborne palynomorphs including those arriving with dust storm and those refloated from the dusty environment contaminate the air, and constitute potential allergens to the populace.

In view of this, the study was therefore, set up to determine the relative quantity of pollen and fungal spores circulating at "head" level (1.65m) in the area and to ascertain the types of fungal spores released within the study period. The two versions of AGWU M6-5 pollen sampling unit used in the study were to be compared for efficiency and performances.

Area of study: The study was conducted in the University of Nigeria, Nsukka campus. The University environment is adorned with numerous aesthetic trees, shrubs and herbs that tend to dominate the natural vegetation of the area. Amidst these, are grasses, herbs, shrubs and some protected wild tree species such as, *Milicia excelsa, Antiaris africana, Alstonia boonei, Parkia biglobosa, Ceiba pentandra, Baphia pubescens, Newbouldia leavis, Elaeis guineensis, Anthocliesta djalonensis, Albizia spp, Vitex, and Nauclea latifolia.*

At the fringes and hilly escarpments around the campus are scattered local herbs, shrubs and trees dominated by the flourishing grass community. The university campus is located at the Northeastern out sketch of Nsukka urban town. Nsukka town is located between latitudes 5° 50' to 7° 00' North and longitudes 7° 15' to 7° 31' East. The environment of the area is humid tropical and dominated by two major seasons: Rainy season (May-October) and dry season (November-April). The South western and the Northeastern trajectories usually dominate the wind systems. The dry season is normally punctuated by the strong cool dry Harmattan wind (NE Trades) that dominates during the dry periods of late November to January.

The vegetation of Nsukka falls within the mosaic of lowland rainforest and savanna grassland (White, 1983). The mean temperature ranges between 24°C and 29°C, while the mean wind velocity for the period of study accelerated from 137.63km/h in November to 168.16km/h in January.

...terials And Methods

Two versions of AGWU M6-5 pollen samplers, Standard Microscope slides, cover slips (24mmx50mm), transparent tape, double faced adhesive tape, Gevatol, 98% ethanol, a pair of forceps and a microscope were used for conducting the study. Of the two samplers, one lacks a hood (Sampler 1), while the other has a hood (Sampler 11). A 3cm x 2cm transparent tape was fixed onto a clean microscope slide using a double-faced adhesive tape. About 0.2mg of Vaseline jelly was smeared on the transparent tape to serve as an adhesive surface. One of such prepared slide was inserted into each sampler and mounted at a height of 1.65m above the ground at a distance of about 1.4m apart. The mounted slides were replaced weekly for a period of three months.

The recovered slides were then permanently prepared for study. Three drops of gevatol were placed on a slide cleaned with 98% ethanol and the tape bearing the palynomorphs was lifted with a pair of forceps and placed face-up centrally on the gevatol-smeared slide. The slide was then gently turned over and placed on a 24mm x 50mm cover slip treated with two drops of gevatol. The weight of the slide caused the gevatol to spread evenly over the surface of the tape. The prepared slides were allowed to rest in that position for about two weeks to enable the palynomorphs settle close to the cover slip. The study lasted from November, 1991-January, 1992. The entire area of the 6cm^2 of the biomaterial section was analyzed so as to register the entire individual particles available.

Results

The air sampling study carried out at "head" level, to assess the quantitative distribution of pollen and spores within the crucial period of the dry season/ harmattan period of November to January, show that the particulate components counted consists mainly of pollen grains and fungal spores from diverse plant species. Others are diatom frustules and plant debris. A total of 4970(11.4%) pollen grains, 33746(77.7%) fungal spores, 2878(6.6%) diatom frustules and 1845(4.24%) plant debris were counted (Table 1). Monthly record of pollen and fungal spores respectively show that 1570 pollen and 16991 spores were counted in November; 1403 pollen and 11183 spores in December and 1997 pollen and 5572 spores in January (Fig. 1).

Pollen grains: The airborne pollen grains trapped in this study over a period of three months showed a marginal variation in the monthly pollen counts. The various pollen types which constitute the entire monthly pollen recorded indicate that in November,

Table 1: List of airborne Palynomorphs trapped

Month	November		December		January		Total
	Sampler1	Sampler2	Sampler 1	Sampler2	Sampler1	Sampler2	
Pollen types							
Trees							
Elaeis guineensis	112	157	119	285	73	322	1068
Anacardium occidentale	3	6	2	0	2	3	16
Mangifera indica	5	10	1	0	0	1	17
Lannea spp	0	0	0	3	10	29	42
Bombax buonopozense	0	0	4	1	0	0	5
Canarium schweinfurthii	3	2	0	1	2	5	13
Carica papaya	17	6	1	2	0	0	26
Casuarina equisetifolia	80	151	7	10	191	258	697
Acalypha spp	6	0	0	0	6	7	19
Hymenocardia acida	0	0	0	0	6	14	20
Irvingia gabonensis	0	0	0	0	0	8	8
Anthocliesta djalonensis	4	5	0	0	1	1	11
Albia zygia	2	2	2	3	0	0	9
Syzygium spp	4	5	4	3	0	3	19
Milicia excelsa	25	35	13	19	88	127	307
Morus mesozygia	0	0	0	0	11	6	17
Treculia africana	2	7	6	5	16	25	61
Pterocarpus spp	1	5	4	0	0	0	10
Azadirachta indica	0	4	2	23	7	3	39
Celtis grandifolia	20	2	0	0	2	4	28
Gmelina arborea	2	1	1	2	0	1	7
Sub-Total	**286**	**398**	**166**	**357**	**415**	**817**	**2439**
Shrubs							
Alchornea cordifolia	67	78	37	47	65	82	376
Ricinus communis	2	5	0	0	0	0	7
Trema guineensis	8	8	0	9	1	5	31
Sub-Total	**77**	**91**	**37**	**56**	**66**	**87**	**414**
Weeds/Herbs							
Amaranthaceae /Chenopodiaceae	16	27	39	60	23	41	206
Asteraceae-liguliflorae type	63	4	0	5	4	4	80
Asteraceae-tubuliflorae type	0	5	4	2	3	1	15
Cyperaceae	15	2	0	0	2	3	22
Luffa spp	2	2	0	2	0	0	6
Olax viridis	0	2	2	8	8	5	25
Crotalaria spp	0	4	2	0	0	0	6
Solanum spp	2	2	0	0	0	0	4
Sub-Total	**98**	**48**	**47**	**77**	**40**	**54**	**364**
Grasses (Poaceae)	177	329	278	348	180	224	1536
Combretaceae /Melastomataceae	22	13	18	6	21	38	118
Unidentified/ Varia	17	14	0	13	12	29	85
Total Pollen/ Month	**677**	**893**	**546**	**857**	**739**	**1258**	**4970**
Fungal spores							
Deuteromycetes spores							
Alternaria spp	146	153	57	79	11	7	453
Asperisporium spp	33	70	52	74	33	31	293
Cladosporium spp	1992	4323	1835	1378	313	925	10766
Curvularia spp	142	185	114	136	51	55	683
Drechslera /Helminthosporium	438	673	474	442	254	352	2633
Nigrospora spp	436	661	605	413	289	388	2792
Pithomyces spp	297	174	83	193	35	24	806
Spegazzinia spp	99	88	93	140	15	28	463

Tetraploa spp	9	36	15	22	19	12	113
Torula spp	100	167	66	111	60	20	524
Fusarium spp	87	156	13	7	2	3	268
Sub-Total	**3779**	**6686**	**3407**	**2995**	**1082**	**1845**	**19794**
Ascospores							
Leptosphaeria spp	79	75	0	2	0	0	156
Pleospora spp	16	24	10	9	6	6	71
Uncinula spp	271	398	77	44	0	0	790
Venturia spp	237	184	53	14	0	0	488
Xylaria spp	141	170	3	4	0	4	322
Sub-Total	**744**	**851**	**143**	**73**	**6**	**10**	**1827**
Basidiospores							
Coprinus spp	83	74	2	6	0	0	165
Puccinia spp	56	95	2	3	0	3	159
Ustilago spp	1447	2615	1567	1582	452	433	8096
Sub-Total	**1586**	**2784**	**1571**	**1591**	**452**	**436**	**8420**
Other fungal spores	450	111	1048	355	706	1035	3705
Total Spores/Month	**6559**	**10432**	**6169**	**5014**	**2246**	**3326**	**33746**
Total pollen and Spores	**7236**	**11325**	**6715**	**5871**	**2985**	**4584**	**37716**
Diatom frustules	237	270	601	500	509	761	2878
Plant debris	84	125	234	306	455	641	1845
Total Palynomorphs	**7557**	**11720**	**7550**	**6677**	**3949**	**5986**	**42439**

the most frequent and abundant pollen types were *Elaeis guineensis, Casuarina equisetifolia, Milicia excelsa, Alchornea cordifolia,* Amaranthaceae /Chenopodiaceae, Asteraceae - liguliflorae type, Poaceae, Combretaceae /Melastomataceae, while in December; *Elaeis guineensis, Milicia excelsa, Azadirachta indica, Alchornea cordifolia,* Amaranthaceae /Chenopodiaceae, and Poaceae predominate. In January, *Elaeis guineensis, Lannea spp, Casuarina equisetifolia, Milicia excelsa, Treculia africana, Alchornea cordifolia*, Amaranthaceae /Chenopodiaceae, Poaceae and Combretaceae /Melastomataceae were more common (Tab.1).

However, from the above outlay, the most frequent and abundant pollen types of the following botanical families were commonly counted: Poaceae, Arecaceae- *Elaeis guineensis,* Casuarinaceae- *Casuarina equisetifolia,* Euphorbiaceae- *Alchornea cordifolia*, Moraceae- *Milicia excelsa*, maranthaceae / Chenopodiaceae, and Combretaceae /Melastomataceae. It is important to observe that *Elaeis guineensis and Casuarina equisetifolia* were the largest single pollen contributors with each contributing approximately 21% and 14% respectively. The quantitative composition of the airborne pollen grains indicates that pollen of anemophilous plant species occurred more abundantly than those of insect pollinated plants. Conversely however, the qualitative occurrence of the plant species, indicate that the insect pollinated plants were recorded more in the study.

From the abundance of pollen types counted, trees, shrubs, weeds/herbs and grasses were found to make unequal contribution to the total pollen load. Of these plant groups, trees contributed the highest pollen load of 49.0% and those of *Elaeis guineensis, Casuarina equisitifolia, Alchornea cordifolia* and *Milicia excelsa* dominated the pollen grains. Grass (Poaceae) pollen grains which contributed 30.9%, increased to its highest peak from November (506) to December (626) and decreased in January (404). That of *Alchornea cordifolia* dominated the (8.33%) pollen contribution by shrubs. The weeds/herbs contributed 7.32% of the total pollen, mostly from Amaranthaceae / Chenopodiaceae, Asteraceae - liguliflorae type, *Olax sp* and Cyperaceae (Fig.2). Of importance in ascertaining the action of man in the environment are the presences of, *Anacardium occidentale, Mangifera indica, Carica papaya, Casuarina equisetifolia, Acalypha spp, Azadirachta indica, Gmelina arborea,* Amaranthaceae / Chenopodiaceae and *Elaeis guineensis*. Generally, the result showed that Twenty-seven (27) plant families were recorded, and of these, eight (8) and twenty (20) pollen types were identified to generic and specific levels respectively. The unclassified pollen grains were grouped collectively under "unidentified/varia" (Tab.1).

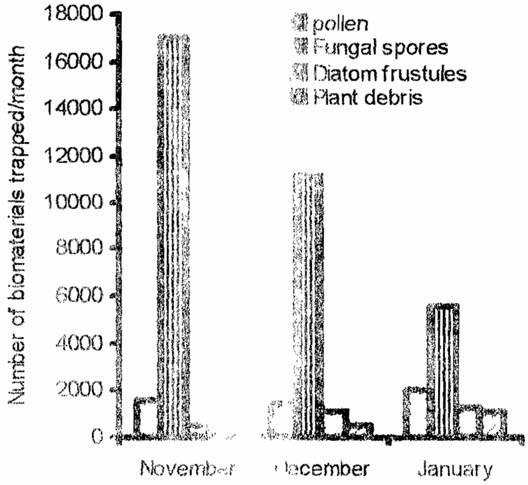

Fig 1. Comparative occurrence of biomaterials trapped/month

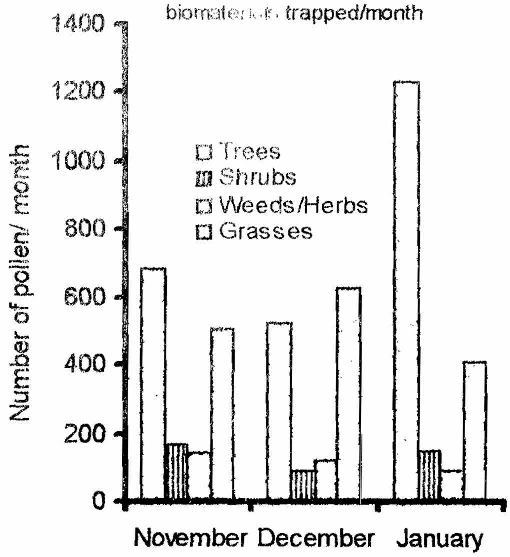

Fig 2. The component plants counted and their relative abundance

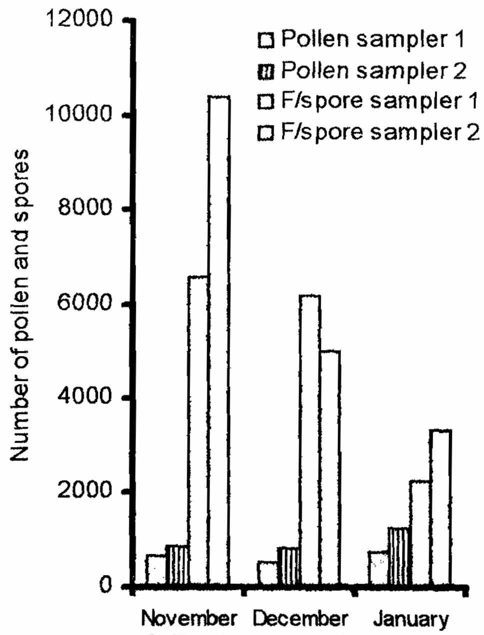

Fig 3. Total pollen and spores trapped/sampler/month

Fungal spores: Nine families of fungal spores consisting of twenty genera were identified in the study. The spores were found to belong to three main groups; Deuteromycetes spores, Ascospores and Basidiospores. The predominant genera recorded in these groups of spores include; Deuteromycetes spores: *Cladosporium, Asperisporium, Torula, Curvularia, Drechslera /Helminthosporium, Nigrospora, Pithomyces, Spegazzinia,* and *Alternaria*; Ascospores: *Pleospora* and *Xylaria*: Basidiospores: *Puccinia* and *Ustilago*. Most of the spores types counted were those of Deuteromycetes and they were more abundant than those of Basidiospores and Ascospores (Tab.1). The quantities of fungal spore counts within the study period indicate that there was a decrease in the counts of spores from November to January. A total of 16991 fungal spores were recorded in November, 11183 spores in December and 5572 spores in January. Of the type of fungal spores counted, the most frequently and abundantly occurring spore types were those of *Cladosporium* (10766), *Ustilago* (8096) *Nigrospora* (2792), *Drechslera /Helminthosporium* (2633), *Pithomyces* (806), *Curvularia* (683) and *Torula* (524). The other spore types which could not be identified and assigned to any particular genera were counted and grouped under "fungal spores" in order to get a good estimation of the total airborne fungal spores.

The comparative counts of trapped components of the two samplers during the three months study period show that Sampler 1 trapped a total of 1962 pollen and 14974 fungal spores, and Sampler 2 trapped a total of 3008 pollen and 18772 fungal spores. Other components also indicate that 1347 Diatom frustules and 773 plant debris were counted in sampler 1, while1537 Diatom frustules and 1072 plant debris were counted in sampler 2 (Tab. I. Fig. 3). The analysis of the results indicates that the total pollen and fungal spores counted in sampler 2 is significantly different ($P<0.05$) from that counted in Sampler 1. The monthly fungal spore counts showed a steady decrease from November (17001) through December (11031) to January (5571). Appreciable quantities of diatom frustules were recorded and the counts show that 507 Diatom frustules were recorded in November, 1101 diatom frustules in December and 1270 diatom frustules in January. Plant debris exhibited a similar trend with increase from November (209) through December (540) to January (1096). The number of Pteridophyte spores recorded were very low as only three (3) spores were encountered in January for the entire study period.

Discussion

An examination of the results with regard to the vegetation of the study area indicates that the many types of airborne pollen and spores recorded in various proportions is a reflection of the existing flora consisting of grasses, herbs/weeds, shrubs and trees as well as fungi and Pteridophytes. The relative quantity and quality of these pollen and spores of the plant species vary monthly and compare favorably with the findings of Agwu and Osibe (1992); Agwu (1997 and 2001); Njokuocha (1997) and Khandelwal (1988). This apparently may be associated with the wide range of plant species found in the environment (Tab.1) and the associated differences in the peak periods of blossom and those of sporadic yearly flowering which are characteristic of tropical vegetation (Keay, *et al.*, 1964; Ewusie, 1980 Hutchinson and Dalziel, 1954-1972).

The large quantity of palynomorphs trapped within this period, at this height (1.65m), gives a glimpse of the amount of air-biomaterials and other particles circulating at head level in the atmosphere. Twenty-seven (27) plant families were identified among others to have contributed to the total pollen counts (Tab.1). Such a large number of families not only portray the vast nature of the plant diversity of the region, but also shows the degree to which pollen types were circulating in the air. Some of the pollen types that occurred more frequently in the environment during the study period include those of *Elaeis guineensis*, Poaceae, Amaranthaceae / Chenopodiaceae, *Casuarina equisetifolia*, *Alchornea cordifolia*, and *Milicia excelsa.* Apart from *Elaeis guineensis* that benefit from wind and insects as pollen dispersal agents (amphiphilous), the rest that are dominant in the airborne pollen are those of anemophilous plants. However, further examinations of the results indicate that qualitatively, greater numbers of entomophilous plant species were counted (Tab.1) and this agrees with the findings of Agwu and Osibe (1992), Agwu (1997and2001) and Njokuocha (1997).

The pollen grains of *Elaeis guineensis, Casuarina equisetifolia,* Amaranthaceae / Chenopodiaceae, Asteraceae, *Mangifera indica, Carica papaya, Solanum spp, Azadiracta indica* and *Gmelina arborea*, though poorly represented, are typical indicators of the intense horticultural and agricultural activities in the environment (Agwu and Osibe, 1992; Agwu,.1997 and 2001). These plants that adorn the environment of the university and the surrounding communities are either planted for their aesthetic values, preserved for their economic values or are common weeds associated with farming activities.

Enormous amount of grass (Poaceae) pollen were counted and constitute about 31.42% of the total pollen count (Tab.1). The high percentage is a reflection of the vegetation constitution of the study area, which is characterized by luxuriant growth of grass community (Agwu, 1997) flourishing in the mosaic savanna vegetation. The increase of grass pollen from November to December and sudden decrease in January could be attributed to the number of flowers in anthesis and subsequent shriveling of the flowers (Agwu and Osibe, 1992 and Njokuocha, 1997) and eventually the whole plant as the environment approaches extreme dryness and destruction through annual bush fires (Fig. 2 and Tab.1).

The pollen from arboreal (trees) plants practically dominated the pollen rain recorded within this dry season. It constitutes about 49.43% of total pollen count. This compares favourably with the findings of Hurtado and Riegler-Goihman, (1987), while shrubs and weeds/herbs together constitute about 18.78% (Fig 2). The major contributors to the arboreal pollen are *Elaeis guineensis, Milicia excelsa, Casuarina equisetifolia*, and *Treculia africana,* which are high pollen producers at the peak of their flowering seasons (Tab.1). They virtually flower fully or partially all year round with peak flowering periods occurring during the dry season of the year (Purseglove, 1975 and Keay, 1989). Generally, the pollen grains of Poaceae, *Casuarina equisetifolia, Carica papaya, Ricinus communis,* Amaranthaceae /Chenopodiaceae, Cyperaceae and many other plant species encountered have been reported to be offending pollen allergens (Singh 1987; Gallup *et. al.*, 1987 and Spieksma, *et al.*, 1985). According to Singh (1987), the majority of the inhalant pollen allergens are from anemophilous taxa because they constitute significant proportion of the air spora exposed to allergic patients. The entomophilous plants are considered to be of less consequence because the quantity of their pollen in contact with the patients may not be sufficient to elicit the sensitization. Never the less the amount of pollen required to provoke an allergic attack may be dependent on the sensitization or susceptibility of the individual.

Fungal spores are of cosmopolitan distribution and constitute a large proportion of the airborne palynomorphs trapped in most aero-palynological studies. Common among these spores identified include those of *Cladosporium, Alternaria, Nigrospora, Pithomyces* and *Drechslera /Helminthosporium.* This result agrees with the findings of Khandelwal, (1988) and Njokuocha, (1997). Although fungal spores are widely distributed in the atmosphere, their relative concentration and distribution in the air are modulated widely by weather conditions as presented in Fig.3 and agrees with Calleja, *et al.*, (1993). There was a marked decrease in the occurrence of airborne spores and pollen from November through December into January (Fig.3 and Tab.1) and this confirms the findings of Royes, (1986), Njokuocha, (1997) and Calleja *et al.*, (1993).

Among the total fungal spore types counted, those of *Cladosporium*, and *Ustilago* emerged as the most dominant constituents of the air spora, contributing 32% and 24.1% respectively. Other frequent and prominent spore types include: *Nigrospora, Curvularia, Pithomyces, Asperisporium, Spegazzinia, Torula and Drechslera /Helminthosporium* (Tab.1). Similar results have been reported by Agwu and Osibe (1992), Njokuocha (1997) for Nsukka and in related investigations in other parts of the world (Prince and Meyer, 1976; Vittal and Glory, 1985; Hurtado and Riegler-Goihman, 1987 and Royce, 1987). This magnitude of spore occurrence and the recorded generic representation is an indication of the quantity and quality of spores circulating at "head level" in the atmosphere. By implication it portrays the degree to which these allergic substances come into contact with the populace and possibly get inhaled or ingested into the human system.

The allergic effects of *Alternaria, Fusarium, Stemphylium, Curvularia, Cladosporium*, *Drechslera / Helminthosporium, Nigrospora, Ustilago* and a host of other fungi counted have been reported by Budd (1986); Lyon *et al.*, (1984); Royce (1987); Frankland (1987) and Gallup *et al.*, (1987). The fungal spores identified belong to the spore producing members of the Deuteromycetes, Ascospores and Basidiospores (Tab.1). Most of the spores recovered belong to the Deuteromycetes, accounting for 57.37% of the entire spores counted. The next in abundance is the Basidiospores (25.1%) followed by the Ascospores (3.7%). The predominance of the genera of Deuteromycetes spore types recorded could be attributed to their ability to associate with a large number of plant species, thus providing a better leverage for their perpetuation and spread. Generally, the prevalence of fungal spores in the Nsukka environment may be said to be associated with the favourable average humidity and temperature of the region, which sustained their growth (Agwu and Osibe 1992; Ofomata 1976).

The two versions of the samplers, from their performance proved functionally good and reliable. However, Sampler 2, a modification of "Sampler 1" from the result can be said to be more efficient and effective in trapping airborne bio-particles (Fig.3 and Tab.1). The difference in the quantity of palynomorphs trapped between the two samplers could be wholly attributed to the attachment of temporary or permanent hood, since the samplers are structurally identical in all other features. Nevertheless, the difference observed may be attributed to retention of a column of air over a longer period under the hood and the reduction of rapid rainout of spores and pollen relative to their position. The increase in fresh water diatom frustules (Lake Chad) and plant debris from November to January is an indication of increasing dryness and the arrival of over long distance transported materials with NE Trade wind (Harmattan). During prolonged dryness, ponds and other water logged areas dry up and expose the fresh water algae (diatoms) to strong harmattan winds, which waft them up into the airwave, causing their increase in the atmosphere.

Conclusion

The air sampling study carried out at "head level" (1.65m) indicates that large quantity of palynomorphs especially fungal spores and pollen grains were present in the atmosphere during November to January period of 1991/92. This is thus, an indication that people were being constantly exposed to high doses of these potential allergens circulating in the air. The pollen grains trapped from arboreal (trees) plants and Poaceae (grasses) were the most predominantly counted in the study. More fungal spores than pollen were recorded in the study, especially those of *Cladosporium, Ustilago, Nigrospora* and *Drechslera /Helminthosporium.* The increase in the presence of pollen from aesthetic plants affirms the great influence of anthropogenic activities in the local vegetation. The new version of AGWU M6-5 Sampling Unit with hood (sampler 2) can be said to be more efficient than the old version and is recommended for future studies of airborne particles.

References

Agwu, C.O.C. (1997). Modern pollen rain in Nsukka: An indication of the vegetation of Nsukka plateau. *Wuerzburger Geographische Arbeiten 91*:97-116

Agwu, C.O.C. (2001). A study of Niger Delta environment through air-borne palynomorphs, Port Harcourt, Nigeria. *Palaeoecology of Africa*, *27*:191-205.

Agwu, C.O.C. and Osibe, E.E. (1992). Airborne palynomorphs of Nsukka during the months of February -April 1990. *Nigerian Journal of Botany, 5*:177-185.

Budd, T.W. (1986). Allergens of *Alternaria*: a review of recent concepts. *Grana*, *21*: 147-154.

Calleja, M; Strick, R.M. and Duzer, D. (1993). Atmospheric pollen content off West Africa. *Review of Palaeoecology and Palynology*, *79*:335-368.

Dupont, M.N. and Agwu, C.O.C. (1991). Environmental control of pollen grain distribution pattern in the Gulf of Guinea and offshore N.W. *Geologische Rundschau*, *80*(3): 567-589.

Ewusie, Y.T.(1980).*Tropical biology for 'O' level and school certificate.* African University Press. 338pp.

Frankland, A.W. (1987). Clinical cross-reactions between various moulds with special reference to *Fusarium*. *Experimentia Supplementum, 51*:147-151.

Gallup, J; Kozak, P; Cummins; L. and Gillman, S. (1987). Indoors mold spore exposure: Characteristics of 127 Home in Southern Califomia, with endogenous mould problems. *Experimentia Supplementum, 15*:72-80.

Hooghiemstra, H; Agwu, C.O.C; and Beug, H.J. (1986). Pollen and spore distribution in recent marine sediment: A record of NW-African seasonal wind patterns and vegetation belts. *Meteor Forch, 40*:87-135.

Hurtado, I. and Riegler-Goihman, M. (1987). Air sampling studies in a tropical area, four years result. *Experimentia Supplementum, 51*:49-53.

Hutchinson, J and Dalziel, J.M. (1954-1972). *Flora of west tropical Africa, vol.3.* Whitefriars, London.

Keay, R.J; Onochie, C.F.A and Standfield, D.P. (1964). *Nigerian Trees*. Vol. 1and2. Nigerian National Press Ltd, Nigeria.

Keay, R.W.J. (1989). *Trees of Nigeria*. Clarendon Press Oxford, 47pp.

Khandelwal, A. (1988). Vertical variation of aerospora concentration at Lucknow. *Geophytology, 18*(2): 173-185.

Lyon, F.L; Kramer, C.L. and Eversmeyer, G.M. (1984). Variation of air spora in the atmosphere due to weather conditions. *Grana*, *23*: 177-181.

Njokuocha, R.C. (1997). *One-year study of vertical distribution of airborne pollen in Nsukka-Nigeria*. M.Sc. Thesis, Department of Botany, University of Nigeria, Nsukka, 96pp unpublished.

Ofomata, G.E.K. (1976). *The 19 Nsukka environment.* Fourth Dimension Publishers, Enugu.

Prince, H.E. and Meyer, G.H. (1976). An up-to date look at mold allergy. *Annal Allergy 37*: 18-25.

Purseglove, W. (1975). *Tropical crops monocotyledons*. Vol.1and2. Longman Group Ltd, London, 607pp.

Royce, V.I.J (1987). Some components of the airspora in Jamaica and their possible medical application. *Grana, 8:151*-157.

Singh, A.B. (1987). Air borne pollen types of allergic significance in India. *Experimentia Supplementum, 51*: 61-68.

Spieksma, F.T.M; Assem, D.V.A and Collete, A.J.B. (1985). Airborne pollen concentration in Leiden, The Netherlands,1977-81. Poaceae (grasses) variations and relation to hay fever. *Grana, 24*:99-108

Street, D.H. and Hamburger, R.N. (1976). Atmospheric pollen and spore sampling in San Diego, C.A.I. meteorological correlation and potential clinical relevance. *Annal Allergy 37*: 32-40.

Sugita, S. (1994). Pollen representation of vegetation in quaternary sediments: theory and method in patchy vegetation. *Journal of Ecology 82*: 881-897.

Vittal, B.P.R. and Glory, A.L.(1985). Air borne fungus spores of a library in India. *Grana 24*: 129-132.

Vittal, B.P.R and Krishnamoorthi, K. (1981). Air spora of an agricultural farm in Madras, India. *Grana 20*: 61-64.

White, F. (1983). *Vegetation of Africa. UNESCO,* Paris.