Aeropalynological Investigation of the University of Ilorin, Ilorin, Nigeria

ABDULLAHI-ALANAMU ABDULRAHMAN1*, ORITSETIMEYIN S. ARUOFOR1, TAOFIK GARUBA2, OPEYEMI SAHEED KOLAWOLE3, GANIYU S. OLAHAN2
FELIX A. OLADELE1

1Applied plant Anatomy and wood Technology Laboratory, Department of Plant Biology, University of Ilorin, Ilorin, Nigeria
2Department of Plant Biology, University of Ilorin, Ilorin, Nigeria
3Department of Biological Sciences, Faculty of Science, Federal University, Kashere, Gombe State, Nigeria

*Corresponding Author: abdulrahamanaa@unilorin.edu.ng

KEYWORDS: Hey fever, meteorological parameters, pollens, spores, climate, University of Ilorin

ABSTRACT: Hay fever allergy could either be from pollen or fungi spores. Using the Hirst model of pollen trap, pollen buckets were constructed; with pollen trap solutions inside them, they were placed in specific locations in the University of Ilorin for four months (December 2012/January 2013 to March/April 2013). Using acetolysis reaction, pollens and spores were recovered from the trap solution and were analyzed and identified in the microscope. Pollen/spore were counted and compared with meteorological parameters i.e. rainfall, sunshine, wind speed, humidity, and temperature. It was observed that pollen/spore concentrations were influenced by these meteorological factors. Hence there is need for us to always determine the amount of these pollen/spore concentrations all year round as it will help to predict the vegetation of a given area as well as helping hay fever sufferers manage their allergies effectively. ©JASEM

http://dx.doi.org/10.4314/jasem.v19i1.7

Introduction

Palynology is the study of dust, strew, sprinkle or particles that are strewn. A classic palynologist analyses particulate sample collected from air, water, or any deposits including sediments of any age. The condition and identification of those particles, organic and inorganic, give the palynologist clues to life, the environment and the energetic conditions that produced them. The term is sometimes narrowly used to refer to a subset of the discipline which is defined as “the study of microscopic objects of macromolecular organic composition (i.e. compounds of carbon, hydrogen, nitrogen and oxygen), not capable of dissolution in hydrochloric or hydrofluoric acids (Sarjeant 2002). The study of these particulates in the air is referred to as aeropalynology. In March 2010, a strange harmattan dust covered the whole of Nigeria and raised issues bordering on changing weather conditions and its consequence on public health. Adeonipekun and John (2011) investigated this cream coloured dust and found out that pollen grains of Guinea/Sudan savanna vegetation species were dominant. This, together with the abundant diatom frustules recorded, further supports a Saharan desert source for the strange dust. Apart from the published work of Adekanmbi and Ogundipe (2010) in the southwest Nigeria and most recently Adeonipekun and John (2011), there is no other aeropalynological work in this area (Ilorin) to serve as a basis for aeropalynological study. Even the Adekanmbi and Ogundipe (2010) work only identified most of the recovered palynomorphs mainly to family level thus not creating the needed basic data for comparative pollen analysis. The work of Adeonipekun and John (2011) also was carried out on the dust deposited on a car bonnet over a month. The sample used was not directly collected from the air with an aerofloral sampler. However, in the southeast Nigeria, works of Agwu and Osibe (1992), Agwu (2001), Agwu et al. (2004), Njokuocha and Osayi (2005) and Njokuocha (2006) have created a rich data base for comparison and research in aeropalynology. These works have not only shown the richness of the aerospora, but have also provided basic data for the twelve months of the year in theNsukka area as well as re-affirming also the contributions of allochthonous sources for the recovered aeropalynomorphs. The works of Adetunji et al. (1979) and Adedokun et al. (1989) on the mineralogy of harmattan dust in Nigeria have confirmed a Saharan source for the harmattan dust and affirmed its significance on the agriculture, health and micro-climate of West Africa and beyond.

Medical palynological and aeropalynological studies however are scarce in Nigeria and little or no known aeropollen data is available for the Ilorin metropolis. Thus the aim of this project research is to identify the concentrations of air borne pollen/fungal spores and the effect of some meteorological parameters in its concentration at the University of Ilorin, Ilorin, Nigeria.

*Corresponding Author: abdulrahamanaa@unilorin.edu.ng
MATERIALS AND METHODS

Study areas: The study was carried out in four (4) selected areas at the University of Ilorin, Ilorin, Nigeria namely Jalala (Junior Staff Quarters), Senior Staff Quarters Unilorin Primary School and Unilorin secondary School.

Construction of pollen trap: A pollen trap was constructed consisting of the following, a four liter transparent bucket and a 25cmx25cm wire mesh. The bucket was filled with 175L of water, 800mL of formaldehyde, 14g of phenol and 1.63L of glycerol. The wire mesh was placed on top of the bucket and fastened with the aid of a wire.

The pollen trap was placed in a hole 30cm deep at each sites of the study. The pollen trap was left for a month and was replaced with another pollen trap solution consecutively for a period of four months starting from December 7th 2012 to April 7th 2013. The recovered palynomorphs were identified after the month of study and were viewed under the optical light microscope and were later identified.

Construction of pollen trap: A pollen trap was constructed consisting of the following, a four liter transparent bucket and a 25cmx25cm wire mesh. The bucket was filled with 175L of water, 800mL of formaldehyde, 14g of phenol and 1.63L of glycerol. The wire mesh was placed on top of the bucket and fastened with the aid of a wire.

Pollen and spore isolation and identification: Acetolysis reaction according to Erdtman (1960) destroys and extracts everything except for the extine, the highly resistant outer shell of the pollen that bears characteristic morphological features used in pollen identification. The extracted pollen was infiltrated with suitable mounting medium for light microscopy. This technique has been used for high resolution 3D imaging of this pollen.

All processing done in a15ml polypropylene conical tube acetolysis reaction was done in the following steps: 6ml of suspended mixture of formaldehyde, phenol, water, and glycerol was obtained and poured in a centrifuge tube; 8ml of water was added to the suspended mixture. The mixture of water and suspension was shaken thoroughly, and centrifuged at 3000 revolutions per minute (rpm) for 15min. It was decanted and 10 ml of Glacial Acetic acid was added. It was centrifuged for the second time at 3000rpm for 10min. Acetolysis mixture was prepared i.e. 9ml of acetic anhydride and 1ml of sulphuric acid. 5ml of this solution was added to the already decanted Glacial Acetic mixture, boiled for about 2 mins at 80-90°C. It was again centrifuged at 3000rpm for 10 mins. It was decanted and washed with distilled water three times; centrifuging at each interval of washing. The residue liquid was stored in the centrifuge tube for subsequent microscopic observations.

Microscopic Analysis: About 10-15 microliters of the washed acetolysed liquid was collected from tube using the micropipette. It was placed on a 25.4x76.2mm microscopic slide. A mountant was added to it to prevent easy dry up of the liquid. Mountant used was glycerol. The cover slide was placed on top of the liquid on the slide. A nail polish was used to seal the edges of the coverslip so as to prevent loss of sample liquid as a result of rapid dry out of the liquid. Thirty-two slides were prepared for each month of study and were viewed under the optical light microscope and were later identified.

Statistical Analysis: All the data gotten were reported and analyzed using Analysis of Variance (ANOVA) and Duncan’s Multiple Range Test (DMRT). The computer software package SPSS 16.0 for windows was used for this analysis. The probability value of 0.05 was used as a bench mark for significant difference between the parameters.

RESULTS

The December/January microscopic analysis reveals total pollen/spore count of 277 belonging to 20 plant families and four fungi families with family Apocynaceae being the most dominant and Aspergillus spp being the most dominant in the fungi families. Other plant families were found in lower amount in the atmosphere. These include families like Cyperaceae, Fabaceae, Poaceae, Liliaceae, Orchidaceae, Alismataceae, Lentibulariaceae, Holaragacea etc. Four species of the fungal family were also identified and these includes; Aspergillus, Penicillium, Cladosporium and Alternaria (Table 1).

In the January/February microscopic analysis a total spore and pollen count of 340 were identified and these belong to 19 plant families and three fungi families; namely Trichocomaceae, Davidellaceae, and Pleosporaceae of which the Caldiosporium ssp was the most dominant spore. The most dominant plant family was the Poaceae family, followed by the Polypodiaceae, Solanaceae and Cyperaceae families. Other families include the Brassicaceae, Annonaceae, Commelinaceae, and the Orchidaceae families (Table 2).
Table 1: Pollen and spore analysis in December 2012 and January 2013 for Jalala area of the University of Ilorin, Ilorin, Nigeria

| S/N | Scientific name     | Family             | Nature of pollen aperture | Frequency of pollen/spore |
|-----|---------------------|--------------------|---------------------------|---------------------------|
| 1   | Celosia argentina   | Amaranthaceae      | Periporate                 | 2                         |
| 2   | Desmodium paniculatum | Fabaceae          | Tricolpate                 | 2                         |
| 3   | Asystasia gagnicita | Acanthaceae        | Tricolporate               | 5                         |
| 4   | Phlebodium aureum   | Polyopodiaceae     | Monolecte                  | 1                         |
| 5   | Utricularia foliosa | Lentibulariaceae   | Polycolporoidate           | 1                         |
| 6   | Taxodium distichum  | Taxodiaceae        | Monoporate                 | 10                        |
| 7   | Alstonia boonoi (de wild) | Acanthaceae | Tricolporate               | 7                         |
| 8   | Salvinia minima     | Salviniaeae        | Trilete                    | 2                         |
| 9   | Physalis pubescens  | Solanaeae          | Tricolporate               | 1                         |
| 10  | Phoenix reclinata   | Aracaceae(palmae)  | Monosulate                 | 8                         |
| 11  | Solanum americanum  | Solanaeae          | Tricolporate-syncolporate  | 3                         |
| 12  | Gomphrena celosioide | Amaranthaceae      | Inaperturate               | 1                         |
| 13  | Asystasia vogeliana | Acanthaceae        | Tricolporate               | 2                         |
| 14  | Cladium mariseas    | Cyperaceae         | Ulcerate                   | 2                         |
| 15  | Sagittaria latifolia| Alismataeae        | Ulcerate                   | 1                         |
| 16  | Sabal palmetto      | Arecaeae           | Monosulate                 | 7                         |
| 17  | Eragrostis elliottis | Poaceae(Grnminea) | Monoporate                 | 5                         |
| 18  | Sagittaria lancifolia| Alismataeae        | Ulcerate                   | 1                         |
| 19  | Crinum americanum   | Liliaceae          | Monosulate                 | 3                         |
| 20  | Alternanthera spp   | Amaranthaceae      | Inaperturate               | 1                         |
| 21  | Thevetia nerifolia  | Apocynaceae        | Tricolporate               | 7                         |
| 22  | Justicia eleganissa | Acanthaceae        | Diporate                   | 9                         |
| 23  | Allamanda cathartica| Apocynaceae        | Tricolporate               | 5                         |
| 24  | Saururus cernus     | Saururaceae        | Monosulate                 | 8                         |
| 25  | Schinus terebinthifolius | Anacardiaceae | Tricolporate               | 4                         |
| 26  | Trichopilia maculate| Orchidaceae        | Inaperturate               | 1                         |
| 27  | Justicia pectoralis | Acanthaceae        | Diporate                   | 3                         |
| 28  | Astrocaryum standleyanum | Palmae             | Panporate                  | 6                         |
| 29  | Oncidium ampiatium  | Orchidaceae        | Inaperturate               | 1                         |
| 30  | Artotolchia pilosa  | Apocynaceae        | Tricolporate               | 7                         |
| 31  | Meschites trifida   | Apocynaceae        | Inaperturate               | 1                         |
| 32  | Chamaedorea ventlandiana | Aracaceae     | Trilete                    | 5                         |
| 33  | Penicillium spp     | Trichocomaceae     | Fungal spore               | 36                        |
| 34  | Aspergillus spp     | Trichocomaceae     | Fungal spore               | 26                        |
| 35  | Alternaria spp      | Pleosporaceae      | Fungal spore               | 21                        |
| 36  | Cladosporium spp    | Davidellaceae      | Fungal spore               | 38                        |
| 37  | Undefined spores    | -                  | -                          | 38                        |

However the February/March 2013 microscopic analysis reveals a slight difference in the pollen, fungal spores (palynomorphs) in the atmosphere. Although persistent families like the Poaceae, Fabaceae, and the Taxodiaceae were present in the atmosphere, however there was a slow fall in their concentrations. The most dominant family was the Cyperaceae. In total, 12 families of plant species and 4 Fungi families were identified. A total of 229 spore/pollen count was recorded (Table 3).

Finally in the March/April 2013 results, pollen/spore concentrations in the atmosphere decrease significantly. Eight plant families and 4 fungal species were identified. A total pollen/spore count was 234 with Cyperaceae being the most dominant in the plant family and Pleosporaceae family being the dominant fungal spore (Table 4).
Table 2: Pollen and spore analysis in January and February 2013 for Jalala area of the University of Ilorin, Ilorin, Nigeria

| S/N | Scientific name             | Family          | Nature of pollen aperture | Frequency of pollen/spore |
|-----|-----------------------------|-----------------|----------------------------|---------------------------|
| 1   | Allamanda catharica         | Apocynaceae     | Periporate                 | 3                         |
| 2   | Asystasia vogeliana         | Acanthaceae     | Tricolporate               | 5                         |
| 3   | Tournefortia angustiflora   | Boraginaceae    | Trilete                    | 2                         |
| 4   | Diplazium grandifolium      | Polypodiaceae   | Monocolporate              | 6                         |
| 5   | Cassia obtusifolia          | Fabaceae        | Tricolporateoidate         | 9                         |
| 6   | Eleocharis cellulose        | Cyperaceae      | Ulcerate                   | 7                         |
| 7   | Asystasia vogeliana         | Acanthaceae     | Monoporate                 | 19                        |
| 8   | Corynthes manculata         | Orchidaceae     | Inaperturate               | 8                         |
| 9   | Anacardium occidentalis     | Acanthaceae     | Tricolporate               | 9                         |
| 10  | Mormodes unalata            | Orchidaceae     | Aporate                    | 6                         |
| 11  | Rhynchospora cephalotes     | Commelinaceae   | Monocolpate                | 9                         |
| 12  | Matelea trianae             | Asclepiadaceae  | Vesculate                  | 5                         |
| 13  | Sagittaria latifolia        | Alismataceae    | Ulcerate                   | 2                         |
| 14  | Commelina diffusa           | Commelinaceae   | Monosulcate                | 4                         |
| 15  | Saururus cernaus             | Saururaceae     | Monosulcate                | 3                         |
| 16  | Thelypteris balbis          | Polypodiaceae   | Monolete                   | 22                        |
| 17  | Trichomaneus godmanii       | Cyanthaceae     | Trilete                    | 7                         |
| 18  | Descariainta pinnata        | Brassicaceae    | Trilete                    | 8                         |
| 19  | Solanum americanum          | Solanaceae      | Tricolporate-synocolpate   | 3                         |
| 20  | Artirochila pilosa           | Rubiaceae       | Tricolporate               | 20                        |
| 21  | Ichanthus pullens           | Poaceae         | Monoporate                 | 9                         |
| 22  | Orthoclada laxa             | Poaceae         | Monoporate                 | 13                        |
| 23  | Paspalidium paniculatum     | Poaceae         | Monoporate                 | 9                         |
| 24  | Leptochloa virgate          | Poaceae         | Monoporate                 | 5                         |
| 25  | Lasiacis procerrima         | Poaceae         | Monoporate                 | 6                         |
| 26  | Paspalum conjugatum         | Poaceae         | Monoporate                 | 5                         |
| 27  | Acer rubrum                 | Aceraceae       | Inaperturate               | 7                         |
| 28  | Thelypteris incise          | Polypodiaceae   | Monolete                   | 4                         |
| 29  | Capsicum annuum             | Solanaceae      | Inaperturate               | 2                         |
| 30  | Geonoma procumbens          | Aceraceae       | Trilete                    | 9                         |
| 31  | Aspidosperma cruenta        | Apocynaceae     | Synocolpate                | 8                         |
| 32  | Desmopsis panamensis        | Annonaceae      | Inaperturate               | 4                         |
| 33  | Alternaria spp              | Pleosporaceae   | Fungal spore               | 27                        |
| 34  | Caldospermium spp           | Davidellaceae   | Fungal spore               | 29                        |
| 35  | Aspergillus spp             | Trichocomaceae  | Fungal spore               | 13                        |
| 36  | Penicillium spp             | Trichocomaceae  | Fungal spore               | 10                        |
| 37  | Undefined spores            | -               | -                          | 35                        |
Table 3: Pollen and spore analysis in February/March 2013 for Jalala area of the University of Ilorin, Ilorin, Nigeria

| S/N | Scientific name | Family | Nature of pollen aperture | Frequency of pollen/spore |
|-----|-----------------|--------|---------------------------|--------------------------|
| 1   | Scetaria puriflora | Poaceae | Monoporate                | 7                        |
| 2   | Cladium maritimum | Cyperaceae | Ulcerate                | 5                        |
| 3   | Eleocharis cellulosa | Cyperaceae | Ulcerate                | 3                        |
| 4   | Acrostichum danaeiilium | Pteridaceae | Trilete                | 15                       |
| 5   | Taxodium distichum | Taxodiaceae | Monolete             | 11                       |
| 6   | Phlebodium aureum | Polygodiaceae | Monolete             | 2                        |
| 7   | Cyperus haspan | Cyperaceae | Ulcerate                | 1                        |
| 8   | Boehmeria cylindrica | Urticaceae | Diporate                | 34                       |
| 9   | Typha latifolia | Typhaceae | Monoulcerate           | 4                        |
| 10  | Thelypteris kunthii | Thelypteridaceae | Monolete             | 6                        |
| 11  | Schoenoplectus | Cyperaceae | Ulcerate                | 10                       |
| 12  | Vigna luteola | Fabaceae | Triporate                | 27                       |
| 13  | Rhynchospora colorata | Cyperaceae | Syncolporate           | 1                        |
| 14  | Morella cerifera | Myricaceae | Ulcerate             | 2                        |
| 15  | Myriophyllum spp | Holaragaceae | Stephanoporate         | 2                        |
| 16  | Pliopsites australis | Poaceae | Monoporate             | 1                        |
| 17  | Ilex cassinii | Aquifoliaceae | Tricorate          | 4                        |
| 18  | Caladosporium | Davidiellaceae | Fugal spore           | 15                       |
| 19  | Aspergillus spp | Trichocomaceae | Fugal spore         | 10                       |
| 20  | Penicilliu spp | Trichocomaceae | Fugal spore           | 18                       |
| 21  | Alternaria spp | Pleosporaceae | Fugal spore          | 17                       |
| 22  | Undefined spores |          |                          | 43                       |

Table 4: Pollen and spore analysis in March/April 2013 for Jalala area of the University of Ilorin, Nigeria

| S/N | Scientific name | Family | Nature of pollen aperture | Frequency of pollen/spore |
|-----|-----------------|--------|---------------------------|--------------------------|
| 1   | Axonopus compressus | Cyperaceae | Monoporate             | 21                       |
| 2   | Eleocharis cellulose | Cyperaceae | Ulcerate                | 4                        |
| 3   | Cassia obnubiflora | Fabaceae | Tricorate          | 10                       |
| 4   | Alahandia catherica | Apocynaceae | Periporate        | 3                        |
| 5   | Tournefortia grandifolium | Boraginaceae | Trilete            | 3                        |
| 6   | Matelea trilanea | Asclepiadaceae | Velsilote      | 1                        |
| 7   | Commelina diffusa | Commelaceae | Tricolporate       | 7                        |
| 8   | Rhynchospora cephaleotes | Commelaceae | Monoporate        | 5                        |
| 9   | Sagittaria latifolia | Alismaceae | Ulcerate             | 9                        |
| 10  | Ayssiatia gaugenica | Acanthaceae | Tricorate            | 9                        |
| 11  | Alstonia booei | Apocynaceae | Tricolporate        | 17                       |
| 12  | Utricularia foliosa | Lentibulariaceae | Polycolate   | 1                        |
| 13  | Phoenix reiniana | Araceae | Diperolate            | 5                        |
| 14  | Justicia petroria | Acanthaceae | Diperolate         | 2                        |
| 15  | Celosia argentea | Acanthaceae | Periporate          | 9                        |
| 16  | Cladium maritimum | Cyperaceae | Ulcerate             | 3                        |
| 17  | Salvina minima | Salvinaceae | Periporate          | 3                        |
| 18  | Boehmeria cylindrica | Urticaceae | Diperolate            | 17                       |
| 19  | Alternaria spp | Pleosporaceae | Fugal spore      | 11                       |
| 20  | Cladosporium spp | Davidiellaceae | Fugal spore     | 29                       |
| 21  | Aspergillus spp | Trichocomaceae | Fugal spore    | 7                        |
| 22  | Undefined spores |          |                          | 21                       |
| 23  | Antiochia pilosa | Apocynaceae | Monolete             | 15                       |

DISCUSSION
The suspension of pollen grains in the atmosphere is a phenomenon that is inherent to the biological function of these particles, since the wind is the major mode of transportation of the pollens and spores of most flowering plants and fungi. It carries the grains from the anthers to the stigma of unisexual flowers, facilitating pollination (Charlesworth 1993) and often the pollen grains of these plants undergo various modifications (Crane 1986). One indirect consequence of this airborne transport is the appearance of allergic reactions in humans when pollen/fungi spore is inhaled and its proteins are released thereby forming antigens to which the immune system reacts, provoking allergic symptoms. As in many other biological processes, pollen/fungi spore dispersal is influenced by meteorological parameters like rainfall, sunshine, temperature and relative humidity. These may determine the timing of the flowering season and release of fungi spores by way of photoperiod, the rate of maturation of conidia, as well as the development of flower organs via their physiology, or by affecting the dynamics of the air ABDULLAHI-ALANAMU ABDULRAHMAN*, ORITSETIMEYIN S. ARUOFOR1, TAOFIK GARUBA, OPEYEMI SAHEED KOLAWOLE1, GANIYU S. OLANAH2, FELIX A. OLADELE1
which the pollens and spores travel as passive elements (Ligthart et al. 1979; Benninghoff 1987).

From the results of this work, spore/pollen count and identification was recorded for the four month period of the study; in all pollen and spore count was most abundant in the Jan/Feb month of the analysis. Spore/pollen count values showed significant correlation with the meteorological parameters. Positive and statistically significant correlation was found between pollen/spore count and the mean temperature (min and max) of the months, wind speed, rainfall and sunshine while negative correlation was observed between the mean relative humidity and pollen/spore count. The amount of sunshine, rain or wind speed affects how much pollen/spore is released and how much the pollen/spore is spread around. On humid day, pollen/spore spreads slowly, during windy days, pollen/spore are transported over long distances (Gregory 1978). Wind speed is therefore recognized as being the most important factor (McDonald 1980).

On rainy days, pollen may be cleared from the air, causing pollen levels to fall. People suffering from pollen and spore allergies look out for the counts whether daily or monthly concentrations to help them start and plan their day (McDonald 1980). The pollen/spore count tells us the amount of pollen in a certain sample of air in a given area.

In the Dec/Jan pollen/spore count, it was noted that pollen dispersal and concentration were not as dense as in the Jan/Feb pollen/spore count. This was attributed to the cold weather as we know anthesis occurs usually in the warm weather hence pollen dispersal was not very effective due to low temperature of the atmosphere. But the fungi spores where much more in abundance, that is to say the cold weather was not much of a factor in the dispersal of these fungi spores because most of these spores are produced from decaying organic matter. In line with this, most of the fungi spores identified are mostly parasitic. For example Aspergillus spp are a major cause of decay of agricultural crops in the field and in storage, and many species are also common in contaminated indoor environments. The Cladosporium spp were found to be the most abundant of the entire fungi spore present. This is to say that mean temperature of 17.45°C and 33.42°C for both the minimum and maximum has an effect on the dispersal of pollen and not really significant in the dispersal of fungi spores. Also the amount of rainfall for Dec/Jan was very low with a total of 7.2mm hence pollen/spore dispersal was not inhibited by rainfall due to the relative concentrations of spores in the atmosphere. The relative humidity also played a role in the dispersal of spore having wet and dry humidity mean values of 17.97% and 19.22% respectively. One can say that pollen dispersal was affected indirectly in the airspora due to loss of water in the anther cell walls that facilitates anther mechanical breakage which releases the pollen (Nitus 2004). The moderate mean wind speed of 80.25km/h for the month of Dec/Jan explains the dispersal and concentration of spores better than all other meteorological parameters. At moderate wind speed, the pollen count in the atmosphere does not decrease, almost to an altitude of 1,000 m. According to Nitus (2004) during the day, when the cloud of pollen is brought up by the convection currents, no selection of pollen grains according to their size and mass takes place, but during the night, especially on a quiet one, larger and heavier grains descend significantly faster than smaller ones reducing the pollen concentration in the atmosphere. The wind is the passive fluid in which pollen and spores travel as passive elements (Ligthart et al. 1979; Benninghoff 1987). The relative high wind speed for the Dec/Jan period of study ensure the dispersal of the spores hence even though the temperature was relatively low there was still enough pollen to cause harm to hay fever suffers.

The Jan/Feb spore count was the highest record of 340 in the period of study. A mean minimum and max temperature of 20.42°C and 34.23°C respectively has no much significance on the pollen/spore distribution during the Dec/Jan period of study as pollen were in much denser concentrations than the fungi spores. The most dominant pollen was from the Poaceae family. The Cladosporium spp of the fungi spore was also in abundance but in lesser amounts as compared to the previous month of study. The increase in rainfall value can be infer to have reduced the concentration of the fungi spore as the rain cleanses the air but that is just an assumption however the mean sunshine hour of 6hrs 50min might be responsible for the increased pollen spore concentrations due to the fact that most plants undergo anthesis (i.e. the opening of flowers) and release pollen early in the morning. As the day gets warmer and more flowers open, pollen levels rise. On sunny days, the pollen count is highest in the early evening. The effect of the humidity on anther opening is also another factor to look out in the pollen abundance of the Jan/Feb period having wet and dry percentage humidity of 19.42 and 20.41 respectively. This may be as a result of the loss of water i.e. dry humidity, tension on the cell walls increases, anthers break up and pollen is released (Nitus 2004). The high wind speed mean of 113.625 KM/H of the Jan/Feb period of study is a major and more distinct factor of pollen/spore distribution. Fluctuations of pollen counts in the different locations of the Jala area of study may be affected by the grains brought from long dispersal and redisposition in the air currents.

The Feb/March period of study records the lowest amounts of spore count of 229. This could be as a
result of the gradual change in the weather from the dry season to the early rainy season. Having a total rainfall of 40.7mm which is much higher when compared to the previous months of the study, the air is said to have being relatively wash free of spores. The minimum and maximum temperature of 23.84°C and 35.52°C could not explain the drop in the pollen concentration. However moderate wind speed of 94.96KM/H explained the reason why pollen/spore were still present although in moderate concentrations in the atmosphere. Wind current disperse pollen/spore randomly and at low speeds selects the pollen/spore. Heavier pollens/spores tend to fall back to the ground leaving only lighter ones in the air. The relative wet and dry humidity of 23.36% and 23.75% respectively could not explain pollen concentration drop due to the narrow significant differences at p<0.05 or p= 0.05.

The March/April result revealed a total spore count value of 234. There is a slight increase in this value in spite of the high amounts of rainfall of 106.7mm. This increase could be inferred from the relatively high mean sunshine value of 7hrs 10min which means flower opening was more due to the warm weather. The mean wind speed of 127.7KM/H which is the highest so far encourages dispersal and redisposition of spores. The mean min and max temperature of 23.90°C and 34.90°C as well as the percentage wet and dry of humidity of 23.30% and 24.45% played no significant role in spore count increments.

Conclusion: From the microscopic and statistical analysis of meteorological effect on pollen/fungi spore in the atmosphere, one can say truly that pollen/spore concentration is influenced by wind speed, rainfall, sunshine, humidity and temperatures. Hence hay fever sufferers should note the amounts of these parameters; in so doing allergies can be effectively managed. Pollen counts alone are unlikely to give an accurate indication of health risks for allergy or asthma sufferers, as pollen potency can vary widely. Hay fever sufferers can become sensitized by other, less allergenic, pollen species in advance of the main pollen season, which may increase the severity of the allergic reaction.

The pollen forecast and pollen calendar (which shows when different types of plant pollen that cause allergic reactions are present in the environment) also involve expert judgment on, and provide information about, the specific allergenic pollen types in the area of interest. Pharmaceutical organizations often use these forecasts not only by displaying it on their website but also to predict demand and supply of medication, such as histamine antagonists (commonly known as antihistamines), which alleviate some of the hay fever symptoms.

Understanding the potential increase in the health burden in relation to allergy will help health organizations and clinicians to plan for the future. There are already significant costs to the economy relating to allergic rhinitis in loss of productivity and days off work. Understanding how this financial burden may increase in the future is another area of potential interest. Further studies that will cover the twelve (12) months and even years should be carried out in the future to account for a more broad coverage of the area in question.

In the Jalala areas pollen count was done in four different locations during the four month period of study a summary of these location and the relative occurrences of spore is highlighted in the table below.
Table 5: Pollen and spore analysis for Primary School area

| S/N | Scientific name       | Family          | Frequency of pollen/spore |
|-----|-----------------------|-----------------|---------------------------|
| 1   | Celosia argentia      | Amaranthaceae   | 3                         |
| 2   | Asystatia gagentica  | Acanthaceae     | 14                        |
| 3   | Utricularia foliosa  | Lentibulariaceae| 1                         |
| 4   | Desmodium paniculatum| Fabaceae        | 2                         |
| 5   | Taxodium distichum   | Taxodiaceae     | 7                         |
| 6   | Alternanthera spp    | Amaranthaceae   | 4                         |
| 7   | Cladium mariserus    | Cyperaceae      | 5                         |
| 8   | Crinum americanum    | Liliaceae       | 1                         |
| 9   | Eragrostis elliota   | Poaceae         | 2                         |
| 10  | Salah palmetto       | Arecaceae       | 3                         |
| 11  | Anacardium occidentalis| Acanthaceae    | 3                         |
| 12  | Matelea trianae      | Asclepiadaceae  | 2                         |
| 13  | Justicia petoralis   | Acanthaceae     | 2                         |
| 14  | Artiophia pilosa     | Apocynaceae     | 7                         |
| 15  | Acrostichum danaefolium| Pteridiaceae  | 15                        |
| 16  | Tournefortia angustiflora| Boraginaceae | 2                         |
| 17  | Cassia obtusifolia   | Fabaceae        | 7                         |
| 18  | Alternaria spp       | Acanthaceae     | 10                        |
| 19  | Thelypterus incise   | Polypodiaceae   | 1                         |
| 20  | Desmopanax pananensis| Annonaceae      | 2                         |
| 21  | Leptochola virginata | Poaceae         | 3                         |
| 22  | Lasiacis procerrima  | Poaceae         | 5                         |
| 23  | Leptochola virginata | Poaceae         | 3                         |
| 24  | Sagittaria latifolia | Alismataceae    | 1                         |
| 25  | Taxodium distichum   | Taxodiaceae     | 6                         |
| 26  | Alternanthera spp    | Amaranthaceae   | 3                         |
| 27  | Cladium mariserus    | Cyperaceae      | 6                         |
| 28  | Cladium mariserus    | Cyperaceae      | 6                         |
| 29  | Cassia obtusifolia   | Fabaceae        | 2                         |
| 30  | Coryanthes manculata | Orchidaceae     | 4                         |
| 31  | Descurainta pinnata  | Brassicaceae    | 5                         |
| 32  | Trichophila manculata| Orchidaceae     | 4                         |
| 33  | Thevita neriifolia   | Apocynaceae     | 4                         |
| 34  | Chamaedorea wendlandiana| Arecaceae      | 3                         |
| 35  | Osmunda regalis      | Osmundaceae     | 6                         |
| 36  | Justicia elegans    | Acanthaceae     | 5                         |
| 37  | Saururus cernus      | Saururaceae     | 4                         |
| 38  | Cladosporium spp     | Davidiellaceae  | 32                        |
| 39  | Alternaria spp       | Pleosporaceae   | 34                        |
| 40  | Undefined spores     |                 | 45                        |

Table 6: Pollen and spore analysis for Secondary School

| S/N | Scientific name       | Family          | Frequency of pollen/spore |
|-----|-----------------------|-----------------|---------------------------|
| 1   | Alsotonia boonie      | Apocynaceae     | 10                        |
| 2   | Utricularia foliosa  | Lentibulariaceae| 1                         |
| 3   | Phoenic reclinata     | Arecaceae       | 3                         |
| 4   | Gomphera celosioides | Amaranthaceae   | 1                         |
| 5   | Rhychnospora cephalotes| Commelinaceae | 14                        |
| 6   | Axonopus compressus  | Cyperaceae      | 34                        |
| 7   | Eleocharis cellulose  | Cyperaceae      | 8                         |
| 8   | Cassia obtusifolia   | Fabaceae        | 6                         |
| 9   | Almada catherica     | Arecaceae       | 2                         |
|10   | Tournefortia grandifolium| Boraginaceae | 27                        |
|11   | Matelea trianae      | Asclepiadaceae  | 4                         |
|12   | Commelina diffusa    | Commelinaceae   | 3                         |
|13   | Sagittaria latifolia | Alismataceae    | 1                         |
|14   | Taxodium distichum   | Taxodiaceae     | 11                        |
|15   | Alternanthera spp    | Amaranthaceae   | 3                         |
|16   | Cladium mariserus    | Cyperaceae      | 2                         |
|17   | Crinum americanum    | Liliaceae       | 2                         |
|18   | Eragrostis elliota   | Poaceae         | 6                         |
|19   | Salah palmetto       | Arecaceae       | 9                         |
|20   | Anacardium occidentalis| Acanthaceae    | 3                         |
|21   | Thelypterus balusis  | Polypodiaceae   | 4                         |
|22   | Justicia petoralis   | Acanthaceae     | 2                         |
|23   | Phleobodium aureum   | Polypodiaceae   | 4                         |
|24   | Alternaria spp       | Pleosporaceae   | 10                        |
|25   | Cladosporium spp     | Davidiellaceae  | 35                        |
|26   | Asperigillas spp     | Trichocomaceae  | 10                        |
|27   | Penicillium spp      | Trichocomaceae  | 18                        |
|28   | Undefined spores     |                 | 34                        |
From the result of the analysis of variance carried out, the location is significant with the F-value of 11.015, at 0.05 alpha level of significance, we reject the null hypothesis and conclude that there is a significant difference in pollen count across the locations in each month. The analysis also indicated that there is significant difference in the pollen count collected with F-value of 8.416, 0.05 alpha level of significance in the months.

Also the analysis of variance (ANOVA), there is significant difference in the effect of the metrological parameters namely humidity (dry and wet), temperature (min. and max.), rainfall, sunshine and wind speed on the amount of pollen count.

| S/N | Scientific name     | Family       | Frequency of occurrence |
|-----|---------------------|--------------|-------------------------|
| 1   | Lasiacis procerrima | Poaceae      | 1                       |
| 2   | Geonoma procumbens  | Aceraceae    | 6                       |
| 3   | Phragmites australis| Poaceae      | 2                       |
| 4   | Celosia argentia    | Amaranthaceae| 8                       |
| 5   | Mormodes ulata     | Orchidaceae  | 2                       |
| 6   | Salvinia minima    | Salvinaceae  | 3                       |
| 7   | Boehmeria cylindrical| Utricaceae  | 7                       |
| 8   | Desmopsis panamensis| Annonaceae  | 1                       |
| 9   | Osmudia regalis    | Osmundaceae  | 9                       |
| 10  | Justicia elegansua | Acanthaceae  | 14                      |
| 11  | Saururus cernus     | Saururaceae  | 2                       |
| 12  | Justicia petoralis | Acanthaceae  | 2                       |
| 13  | Antolochia pilosa  | Rubiaceae    | 27                      |
| 14  | Ichanthus pallens  | Poaceae      | 9                       |
| 15  | Orthoclada laxa    | Poaceae      | 6                       |
| 16  | Paspalidium paniculatum| Poaceae  | 9                       |
| 17  | Leptochloa virgate | Poaceae      | 2                       |
| 18  | Aspidopserma cruenta| Apocynaceae| 6                       |
| 19  | Paspalum conjugatum| Poaceae      | 6                       |
| 20  | Acer rubrum         | Aceraceae    | 7                       |
| 21  | Thelypterys incise | Polypodiaceae| 3                      |
| 22  | Capsicum anuum     | Solanaceae   | 3                       |
| 23  | Cyperus haspan     | Cyperaceae   | 17                      |
| 24  | Coryanthes manculata| Orchidaceae | 2                       |
| 25  | Descurainta pinnata| Brassicaceae | 2                       |
| 26  | Trichophila manculata| Orchidaceae| 4                       |
| 27  | Thevitia neriifolia| Apocynaceae  | 3                       |
| 28  | Chamaedorea wendlandiana| Areaceae| 2                       |
| 29  | Desmopsis panamensis| Annonaceae  | 11                      |
| 30  | Antolochia pilosa  | Apocynaceae  | 8                       |
| 31  | Phragmites australis| Poaceae      | 3                       |
| 32  | Celosia argentia    | Amaranthaceae| 3                       |
| 33  | Mormodes ulata     | Orchidaceae  | 4                       |
| 34  | Axonopus compressus| Cyperaceae   | 16                      |
| 35  | Sagittaria latifolia| Alismataceae| 1                       |
| 36  | Diplazium grandifolium| Polypodiaceae| 6                      |
| 37  | Coryanthes manculata| Orchidaceae | 2                       |
| 38  | Descurainta pinnata| Brassicaceae | 1                       |
| 39  | Alamanda catherica | Apocynaceae  | 3                       |
| 40  | Anacardium occidentalis| Acanthaceae| 3                       |
| 41  | Trichomanes godmanii| Cyntheaceae | 4                       |
| 42  | Shoenoplectus tabaraeontiani| Cyperaceae| 3                       |
| 43  | Rhinospora colorata| Cyperaceae   | 3                       |
| 44  | Myriophyllum spp    | Holaragaceae | 8                       |
| 45  | Alternaria spp      | Pleosporaceae| 11                      |
| 46  | Caldosporum spp     | Davidellaceae| 35                      |
| 47  | Aspergillus spp     | Trichocomaceae| 17                      |
| 48  | Penicillium         | Trichocomaceae| 10                      |
| 49  | Undefined spores    |              | 27                      |
Table 8: Pollen and spore analysis for Senior Staff Quarters

| S/N | Scientific name         | Family          | Frequency of pollen/spore |
|-----|-------------------------|-----------------|---------------------------|
| 1   | Alumanda catherica      | Apocynaceae     | 3                         |
| 2   | Asystasia vogeliana     | Acanthaceae     | 7                         |
| 3   | Tournefortia gandolfiun | Boraginaceae    | 1                         |
| 4   | Cassia obtusifolia      | Fabaceae        | 6                         |
| 5   | Eleocharis celulose     | Cyperaceae      | 10                        |
| 6   | Commelina diffusa       | Commelinaeae    | 8                         |
| 7   | Trichomanes godmanii    | Cyatheaceae     | 3                         |
| 8   | Thelypteris balbis      | Polyodioaceae   | 4                         |
| 9   | Solanum americanum      | Solanaceae      | 10                        |
| 10  | Aspidosperma cruenta    | Acanthaceae     | 2                         |
| 11  | Paspalum conjugatum     | Poaceae         | 2                         |
| 12  | Celosia argentina       | Amarantaceae    | 15                        |
| 13  | Geonomia procumbens     | Acereace        | 3                         |
| 14  | Leptochloa virgate      | Poaceae         | 1                         |
| 15  | Orthoclada laxa         | Poaceae         | 7                         |
| 16  | Boehmeria cynthia       | Uricaceae       | 18                        |
| 17  | Ilh cassine             | Aquifoliaceae   | 4                         |
| 18  | Osmunda regals          | Osmudaceae      | 3                         |
| 19  | Alstonia boonei         | Acanthaceae     | 14                        |
| 20  | Salvinia minima         | Salvinaceae     | 2                         |
| 21  | Saururus cernus         | Saururaceae     | 4                         |
| 22  | Schinus terebinthifolius| Anacardaceae    | 4                         |
| 23  | Justicia petorulis      | Acanthaceae     | 2                         |
| 24  | Phoenix reclinata       | Areaceae        | 4                         |
| 25  | Oncidium amplificatum   | Orchidaceae     | 7                         |
| 26  | Sagittaria latifolia    | Alismateaceae   | 1                         |
| 27  | Sabal palmetto          | Areaceae        | 2                         |
| 28  | Cladium mariseus        | Cyperaceae      | 3                         |
| 29  | Taxodium distichum      | Taxodaceae      | 3                         |
| 30  | Alternanthera spp       | Amarantaceae    | 2                         |
| 31  | Alternaria spp          | Pleposoraceae   | 8                         |
| 32  | Cadlosprium spp         | Davidellaceae   | 17                        |
| 33  | Aspergillus spp         | Trichocomeaceae | 26                        |
| 34  | Penicillium             | Trichocomeaceae | 16                        |
| 35  | Undefined spores        | Trichocomeaceae | 16                        |

Table 9: Monthly effects of meteriological parameters on aeropalynomorphs concentration

| Month     | Dry humidity | Wet humidity | Minimum temperature | Maximum temperature | Rainfall | Sunshine | Wind speed |
|-----------|--------------|--------------|---------------------|---------------------|----------|----------|------------|
| Dec. 2012-Jan. 2013 | 19.2258b     | 17.9677a     | 17.4516c            | 33.4194b           | 7.7000a  | 8.2000a  | 41.4194b   |
| Jan-Feb 2013    | 20.4194b     | 19.4135a     | 20.4194c            | 34.2258b           | 1.4000a  | 6.9000a  | 56.6452b   |
| Feb-Mar 2013    | 23.7500c     | 23.3571a     | 23.8381b            | 35.5161d           | 40.7000a | 6.7732a | 95.0000e   |
| Mar-Apr 2013    | 24.4516d     | 23.2903a     | 23.9032b            | 34.9032b           | 1.0670E2 | 7.1339b | 127.7097f  |
| Total          | 21.9617      | 21.0072      | 21.4031             | 34.5161            | 39.1250  | 7.2518   | 80.1936    |

There is significant difference in the values of means in the column not followed by the same superscript

REFERENCES

Adedokun, J. A., Emofurieta, W. O., Adedeji, O. A. 1989. Physical mineralogical and chemical properties of harramatt dust at Ile-Ife, Nigeria. Theor. Appl. Climatol. 40: 161 – 169.

Adekannobi, O., Ogundipe, O. 2010. Aeropalynological studies of the University of Lagos campus, Nigeria. Notulae Scientia Biologicae 2(4):34-39.

Adepjipekan, P. A., John, M. 2011. Palynological Investigation of Haze Dust in Ayetoro-Itele Ota, Southwest Nigeria. J. Ecol. Nat. Environ., 3(14):455-460

Adetunji, J., Mcgregor J., Ong, C. K. 1979. The harramatt haze. Weather J. 34:430-436.

Agwu, C. O. C. 2001. A study of Niger Delta environment through airborne polynmorphs, Port Harcourt, Nigeria. Palaeoecol. Afr., 27:191-205.

Agwu, C. O. C., Njokuacha, R. C., Mezue, O. 2004. The study of airborne pollen and spores circulating at "Head Level" in Nsukka environment. Bio-Res., 2(2): 17-14.

Agwu, C. O. C., Osibe, E. E. 1992. Airborne polynmorphs of Nsukka during the months of February – April, 1990. Niger. J. Bot., 5: 177-185

Altinta, D. U., Karakoc, G. B., Yilmaz, M., Pinar, M., Kendirli, S. G., Cakan, H. 2004. The relationship between pollen counts and weather variables in East Mediterranean Coast of Turkey. Development Immunology 2:87-37.
Anderson, S. T. 1980. Influence of climatic variation on pollen season severity in wind pollinated trees and herbs. Grana 19:47-52.

Benninghoff, W. S. 1987. Environmental influences on deposition of airborne particles. In: Boehm G, Leusner RM (eds) Advances in Aerobiology. Proceeding of the 3rd International Conference on Aerobiology. Birkhäuser, Basel. pp 11-18.

Charles, B., Freiday, P., Julie, L., Frank, H., Jay, P. 2001. The effect of temperature, relative humidity and rainfall on airborne ragweed pollen concentrations. Aerobiologia 17:61-68.

Charlesworth, D. 1993. Why are unisexual flowers associated with wind pollination and unspecialized pollinators? Am Nat141:481-490.

Claypoole, S. T., Slesnick, U. L. 1983. The beauty and biology of pollen. American Biology Teacher 45:366-370.

Crane, P. R. 1986. Forms and function in wind dispersed pollen and spore;form and function Ed. S. Blackmore and I.K. Ferguson London: Academic press, pp179 - 202.

Dale, P. J., Clarke, B., Fontes, E. M. 2002. Potential for the environmental impact of transgenic crops. 20: Nature Biotechnology 567-574.

Erdtman, G. 1960. The acetylosis method, A Revised Description, Svensk Botany Tidskr., 51: 561-567.

Feher, Z., Jari-Comlodi, M. 1996. Relationship between airborne ragweed pollen concentration and the macrosynoptic weather types in Budapest, Hungary. Ann. Agric. Environ. Med. 3:121-126.

Gregory, P. H. 1978. Distribution of airborne pollen and spores and their long distance transport. Pure Appl Geophys, 116:309–315.

Hasnain, S. M., Fatima, K., Al-Frayh, A., Al-Sedainy, S. 2005. One-year pollen and spore calendars of Saudi Arabia Al-Khobar, Abha and Hofuf. Aerobiologia 21:241-247.

Kaplan, A. 2004. Airborne pollen grains in Zonguldak, Turkey, 2001-2002. Acta Bot. Sin. 46:668-674.

Levetin, E. 1991. Identification and concentration of airborne Basidiospores. Grana 30:123-128.

Lighthart, B., Spendlove, J. C., Akers, T. G. 1979. Sources and characteristics of air borne materials. Factors in the production, release and viability of biological particles In: Edmonds R. L. (Ed) Aerobiology. The ecological systems approach. Dowden Hutchinson & Ross, Stroudsburg, pp. 11-84.

Mc Donald M. S. 1979. The effect of meteorological conditions on the concentration of airborne pollen over an estuarine area on the west coast of Ireland. Pollen spores 21:233-238.

Mc Donald, M. S. 1980. Correlation of airborne grass pollen levels with meteorological. Grana, 19: 53-56.

Murray, M. G., Sonaglione, M. I., Villamil, C. B. 2002. Annual variation of airborne pollen in the city of Bahia Blance, Argentina. Grana 41:183-189.

Newham, R. M. 2001. Aeropalynology and global warming, pp. 570. In: Goodman, D. K. and R. T. Clarke (Eds.). Proceedings of the IX International Palynological Congress, Houston, Texas, U.S.A., 1996; American Association of Stratigraphic Palynologists Foundation.

Nitius, D. S. 2004. Intradiurnal fluctuation of pollen in La Plata, Argentina. Part II, herbaceous pollen types. Aerobiologia, 20: 69-74.

Njokuocha, R. C. 2006. Airborne pollen grains in Nsukka, Nigeria. Grana, 45(1): 73-80.

Njokuocha, R. C., Osayi, E. E. 2005. Airborne pollen and spore survey in relation to allergy and plant pathogens in Nsukka, Nigeria. Bio-Research, 3(1): 77-84.

Paloma, C., Carmen, G. A. 2004. Purificacion and D. Eugenio Airborne pollen records response to climatic conditions in arid areas of the Iberian Peninsula. Environ. Exp. Bot. 52: 11-22.

Sarjeant, W. A. S. 2002. As chimney-sweeps, come to dust: a history and out: some major contributions to geology in the twentieth century. Geological Society (London) Special Publication no. 192.

Subiza, J. J., Masiello, M., Subiza, J. L., Jerez, M., Hinojosa, M., Subiza, E. 1992. Prediction of annual variations in atmospheric concentration of grass pollen. A method based on meteorological factors and grain crop estimates. Clin. Exp. Allergy 22:540-546.

Tejera, L., Beri A. 2005. First volumetric airborne pollen sampling in Montevideo City, Uruguay. Aerobiologia 21:33-41.

ABDULLAHI-ALANAMU ABDULRAHAMAN*1, ORITSETIMEYIN S. ARUOFOR1, TAOFIK GARUBA2, OPEYEMI SAHEED KOLAWOLE1, GANIYU S. OLAHAN2 FELIX A. OLADELE1