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Aeropalynological Study of Obukpa town, Enugu State, Nigeria

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Abstract

The diversity and abundance of airborne palynomorphs and other bio particles in the atmosphere of Obukpa was studied for a period of three months, from June through August 2010. The palynomorphs were trapped with Tauber sampler mounted at three locations during the period of study. A total of three thousand, eight hundred and ninety-nine (3,899) palynomorphs consisting of 3365 (86.3%) pollen grains, 496 (12.72%) fungal spores and 38 (0.98%) of other bio particles (insect parts and trichomes) was identified from the study. The pollen types which dominated the atmosphere of the sampled area included members of Combretaceae/Melastomataceae, Poaceae, Asteraceae, Amarathaceae, *Lannea* sp., *Pentaclethra macrophylla* and *Alchornea cordifolia.* The identified pollen grains were representatives of some trees, shrubs, herbs and grasses. The major contributors to the fugal aerospora were *Glomerularia* sp., *Nigrospora* sp., *Cercospora* sp., *Asperosporium* sp., *Fusoma*, *Dreschlera*, *Helminthosporium* and so on. Comparatively, there were variations in the quantity of the trapped palynomorphs during the three months study period which could have resulted from differences in the flowering period of the plants as well as influence of some meteorological factors such as rainfall, temperature, wind speed, relative humidity and wind direction.

Key words: Palynomorphs, Pollen types, bio particles, fungal spores, atmosphere

INTRODUCTION

The atmosphere contains lots of suspended particles including palynomorphs that vary greatly in size, shape and density and from different sources (Essien and Agwu, 2013). Palynomorphs such as pollen and spores exhibit seasonal fluctuations in quantity and composition. The type and quantity of airborne palynomorphs in the atmosphere at any point in time depends on a number of factors such as atmospheric humidity, rainfall, temperature, wind velocity and direction (Agwu and Osibe 1992). Airborne palynomorphs are a major cause of respiratory ailments of humans, causing allergies, asthma, and pathogenic infections of the respiratory tract (Essien *et al.*, 2013). Generally, pollen grains of anemophilous plants are the major causes of allergies because they can produce copious quantities of light weight pollen which can be transported to far distances. According to Singh and Rawat (2000), they are easily inhaled, which makes them come in contact with the sensitive nasal passages. Airborne fungal spores are minute, unicellular or multicellular reproductive bodies released into the atmosphere mostly by the action of winds and rain drops (Ajikah *et al.*, 2015). Many fungi depend exclusively on wind regime for the release of their spores and dispersal. Spores form part of the life cycle of many bacteria, plants, algae, fungi and some protozoans. They are among the most abundant and least well-known airborne allergens. This makes it vital to study the seasonal and diurnal periodicities of these airborne fungal spores over a given period (Njokuocha and Osayi, 2005).

Studies on the abundance and types of palynomorphs circulating in the atmosphere and their seasonal occurrence and implications have been conducted in various parts of Nigeria by some authors (Ezikanyi *et al*., 2016; Essien, 2014; Ezikanyi and Sakwari, 2018). Similarly authors have also correlated the abundance of these palynomorphs in the atmosphere with some meteorological factors and reported that they are at increase particularly during the dry season because of some factors like low relative humidity and high wind speed which aid their aerial transport (Njokuocha, 2006; Essien *et al*., 2013; Adekanmbi and Olugbenga. 2018). Njokuocha *et al*. (2018) conducted a study on the abundance of airborne mycoflora and allergenic fungal spores of Enugu-North, Nigeria in which it was reported that meteorological factors influenced significantly the abundance of some of the identified aero palynomorphs.

Although these studies have furnished significant information regarding concentrations of fungal spores and pollen grains in the atmosphere and their implications, a continuous survey of airborne pollen and fungal spores is important as this will help to establish the general role of pollen incidence as well as documenting periods which are comparatively safe for the hay fever sufferers in Nigeria. This study therefore is a further contribution to the aeropalynological study of the abundance and distribution of airborne palynomorphs of Nsukka area in Enugu State, Nigeria.

MATERIALS AND METHODS

Study Location

The sampling site was at Obukpa, Nsukka Local Government Area of Enugu State and three locations were chosen for the study. Nsukka is a well populated place and sub-urban town located on a plateau at an elevation of 419.4 m above sea level. It is boarded on the East by Anambra plains and on the South-west by Udi highlands (Agwu, 1997). Nsukka climate is humid and tropical with monthly temperature oscillating between 24^0C and 29^0C and with a range of about 10^0C during the year. The climate is characterized by alternating rainy and dry seasons; the former lasting from May to October and the later from November to April. The dry season is accentuated in its dryness by the dust bearing harmattan wind (NE) from December and January (Agwu, 1997). It is located in the mosaic of lowland rainforest (White, 1983) otherwise known as rainforest savannah ecotone, with grasses constituting about 60-70% of the vegetation cover (Ofomata, 1975).

Methods

The study was carried out for a period of three months from July through August 2010. Samples were collected using Tauber's pollen trap (Tauber, 1977) covered with a lid that has small opening on top which serves as an inlet for pollen and spores. Mixture of fifty (50 ml) of glycerol, 25 ml of formaldehyde and 5 ml of water was prepared and poured into the Tauber samplers at different locations. The content of the traps was collected monthly over a period of three months and replaced with a fresh solution after each monthly harvest. The collected samples were sieved through 200 μ -mesh copper wire gauze to filter of large organic and inorganic particles.

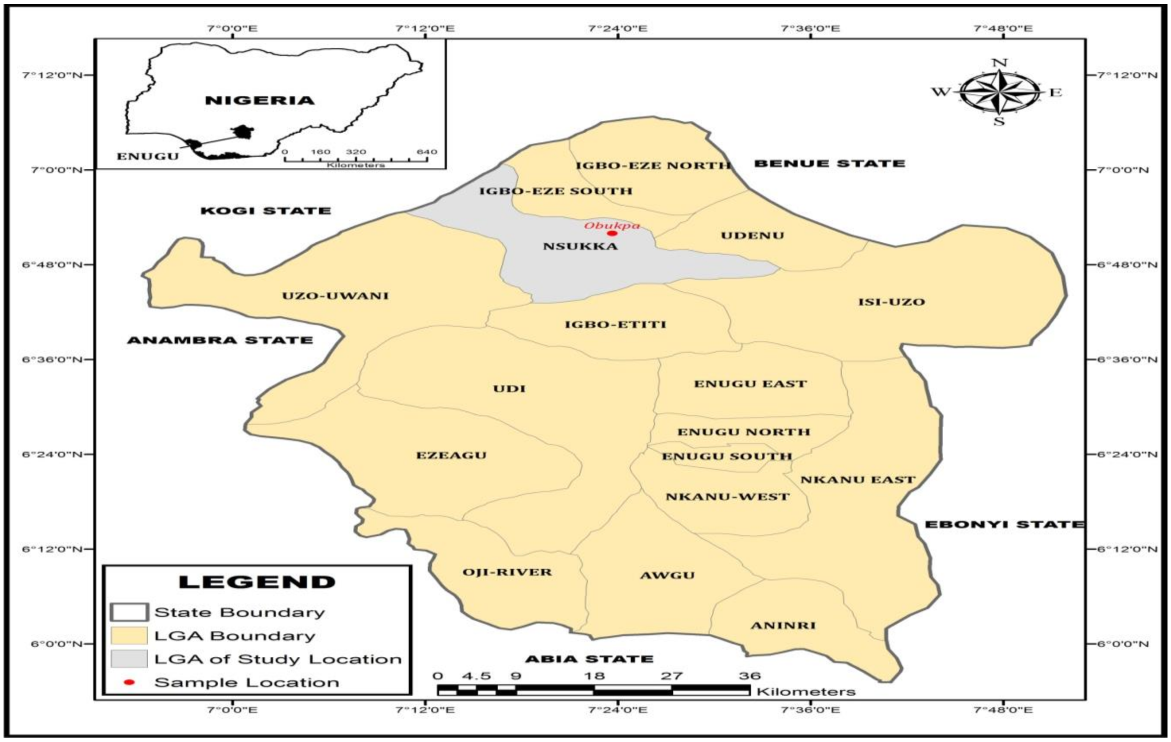

Figure. 1: Map of Enugu State showing the study location

SOURCE: United State Geological Survey, 2019 modified by Cartography Unit, Department of Geography, University of Nigeria Nsukka.

They were then centrifuged at 2,500 revolutions per minute (rpm) for five minutes to concentrate the trapped particles. The supernatant was decanted, and the residue retained. The residues were subjected to acetolysis following the procedures of Erdtman (1969). Ten mililitres of acetolysis mixture (9 ml of acetic anhydride plus 1 ml of tetraoxosulphate vi acid) was added into each of the samples and boiled. The acetolysed pollen grains were washed once with glacial acetic acid and twice with water. Centrifugation was done for ten minutes at 2500 rpm after each washing. Two drops of glycerol-alcohol were added to the polliniferous residue and stored in vial bottles from where samples were taken for microscopy. Two drops of the sample were placed on a slide and covered with a cover slip (22 x 22 mm) and examined microscopically. Palynomorphs were identified and counted with Olympus CH microscope at x 400 magnification.

Identification of pollen and spores was carried out with the help of reference pollen slides collections in the Palynology Research Unit, Department of Plant Science and Biotechnology, University of Nigeria Nsukka as well as photographs and description in books and journals like (Ybert, 1979; Boneffille and Riollet, 1980; Sowunmi, 1995; Gosling *et al*., 2013).

RESULTS

The analytical study of airborne palynomorphs trapped from the atmosphere of Obukpa Nsukka displayed the presence of biological materials consisting of pollen grains, fungal spores, trichomes as well as insect parts. Pollen of different plant families were identified at different sampling periods. In all, a total of 3,365 pollen grains and 496 fungal spores were counted from samples obtained from the three months collection (Table 1). A total of twenty (20) pollen types belonging to seventeen (17) families of flowering plants and 19 spore genera were identified (Tables 2 and 3). The monthly pollen count showed that a total of 1,030 (30.61%) pollen grains were recorded in June, 838 (24.90%) in the month of July and 1497 (I44.49%) in the month of August (Tables 1 and 2). The study showed continuous presence of pollen grains of families of Combretaceae/Melastomataceace, Poaceae, Asteraceae, Amarathaceae/Chenopodiaceae, Anacardiaceae and Fabaceae. Some of the pollen grains that were identified to the species level include *Alchornea cordifolia, Elaeis guineensis, Adansonia digitata, Delonix regia, Isoberlina doka, Hymenocardia acida, Penthaclethra macrophylla* etc.

The fungal spore count showed that the highest spore count occurred in the month of June (183/36.9%) followed by August (172/34.7%) and then July 141(28.4%) (Tables 1 and 3). The most commonly encountered and abundant fungal spores during the period of sampling were *Glomerularia* sp. (102/20.6%), *Cercospora* sp. (62/12.5%), *Nigrospora* (63/12.7%) and so on (Table 3). Other Fungal spores which were also regular in their occurrence include *Spadicoides* (27/5.4%), *Dreschlera* (18/3.6%), *Torula* (16/3.20%) and *Curvularia* (15/3.0%). Other constituents of the atmosphere trapped during the study include trichomes and insect parts. Out of the three thousand, eight hundred and ninety-nine (3899) palynomorphs counted, trichomes contributed (35/0.9%) while insect parts contributed (3/0.08%) (Table 1).

Table 1: Trapped airborne palynomorphs during the study period

Palynomorphs	June	July	August
Pollen grains	1030 (30.61%)	838(24.90%)	1497(44.49%)
Fungal spores	183(36.9%)	141(28.4%)	172(34.7%)
Insect parts	0(0)	2(0.05%)	1(0.03%)
Trichomes	16(0.4%)	8(0.2%)	11(0.3%)

DISCUSSION

Pollen grains and spores are transported from one place to another. Aeropalynological investigation of the trapped airborne particles revealed the presence of different pollen grains and spore types and other atmospheric constituents in the atmosphere of Obukpa town during the study period. Monthly variations in the count of airborne palynomorphs were observed in the recorded palynomorphs and this may have resulted from fluctuations in the suspended palynomorphs in the atmosphere during the sampling period.
Variations in monthly count of airborne palynomorphs have been reported by some authors in Nigeria (Njokuocha and Osayi, 2005; Njokuocha, 2006; Adeniyi *et al*., 2014, Njokuocha *et al*., 2018). Njokuocha (2006) reported that high numbers of pollen grains are observed during the late rainy season- early dry season/ Harmattan (September to December). These variations in the monthly palynomorphs counts of families and individual palynomorphs types at different locations also suggest that the abundance of palynomorphs is influenced not only by the meteorological factors but also the existing vegetation type as well as flowering phenology of the plants among others (Agwu and Osibe, 1992; Agwu, 1997; Essien, 2014). Apart from the meteorological factors, the concentration of atmospheric pollen content was as well considered to be greatly affected by the geographical distribution of the pollen producers and the period of main pollen release (Calleja *et al*., 1993). The predominant pollen types and families of plants such as those of *Terminalia* sp., *Lannea* sp., *Pentaclethra macrophylla*, *Alchornea cordifolia*, Poaceae, Asteraceae and Amaranthaceae have also been identified in some aeropalynological studies carried out by some authors in Nigeria (Agwu *et al.,* 2004; Adekanmbi and Ogundipe, 2010; Adeonipekun, 2012).

Table 2: Monthly count of pollen grains during the three months study period

			June			July			August		
S/N	Pollen Families	Pollen Types	L 1	L 2	L 3	L 1	L 2	L 3	L1	L 2	L 3
1	Amaranthaceae		44	21	10	15	11	16	42	29	18
2	Anacardiaceae	*Lannea* sp.	19	1	0	8	1	0	7	3	15
		Isoberlina doka	0	5	0	0	0	0	0	0	0
3	Annonaceae	*Cleistopholis patens* (Benth.) Engl. & Diels.	0	0	0	0	2	0	0	0	0
4	Arecaceae	*Elaeis guineensis* Jacq.	0	0	0	0	0	0	0	2	0
5	Asteraceae	Other species	74	29	30	25	41	16	89	72	45
6	Bombacaceae	*Adansonia digitata* Linn.	0	0	0	0	1	0	0	0	0
7	Fabaceae (Caesalpinioideae)	*Delonix regia* (Boj. Ex Hook.) Raf.	1	0	0	0	0	0	0	0	0
		Isoberlinia doka Craib & Stapf	0	5	0	0	0	0	0	0	0
		Other species	6	47	9	12	2	2	3	0	0
	Fabaceae (Mimosoideae)	*Pentaclethra macrophylla* Benth.	2	0	8	0	2	4	7	8	3
8	Capparidaceae	*Cleome parvipetala* R.A.Grah.	4	0	0	0	0	0	0	0	3
9	Combretaceae/ Melastomataceae	*Terminalia* sp.	181	111	105	162	166	55	229	163	240
		Combretum sp.	93	40	10	33	51	13	64	38	118
10	Ebeneceae		1	0	0	0	0	0	0	0	0

11	Euphorbiaceae	*Alchornea cordifolia* Schum. & Thonn.) Mull. Arg.	5	0	1	9	5	4	7	2	1
12	Hymenocardiaceae	*Hymenocardia acida* Tul.	0	0	0	1	0	0	0	0	0
		Microdesmis sp.	0	3	0	0	2	0	0	0	0
13	Lamiaceae	*Leonotis nepetifolia* (L.) W.T. Ait.	0	0	0	0	0	0	0	0	1
		Leucas sp.	0	0	0	0	0	0	0	2	0
		Ocimum hadiense Forssk	0	0	0	1	0	0	0	0	0
14	Moraceae	*Morus* sp.	0	0	0	0	1	0	0	1	0
15	Poaceae		91	45	34	55	54	66	120	80	70
16	Sapindaceae	*Allophylus africanus* P. Beauv	0	0	0	0	0	1	0	0	0
17	Ulmaceae	*Celtis intergrifolia* Lam.	0	0	0	1	0	0	0	0	0
		Location total	521	302	207	322	336	180	568	410	519
		Location percentage	15.5%	9%	6.2%	9.6%	10%	5.4 %	16.9%	12. 2%	15.4 %
		Monthly total/percentage	1030/30.61%			838/24.90%			1497/ 44.49 %		

L1= Location 1; L2= Location 2; L3= Location 3

Table 3: Monthly count of fungal spores during the three months study period

		June			July			August		
S/N	Fungal Spores	L I	L 2	L 3	L 1	L 2	L 3	L 1	L 2	L 3
1	*Alternaria*	0	1	1	1	1	0	2	1	0
2	*Asperosporium*	4	0	2	6	7	3	8	5	8
3	*Blastomyces*	0	0	0	1	0	0	0	0	0
4	*Cercospora*	6	10	8	7	4	6	4	6	11
5	*Cladosporium*	1	1	2	2	2	0	1	0	3
6	*Cordana*	0	0	0	0	0	0	1	0	0
7	*Curvularia*	2	0	0	3	2	3	0	2	3
8	*Dreschlera*	0	2	3	1	1	2	4	4	1
9	*Fusarium*	0	1	0	0	1	0	0	0	0
10	*Fusoma*	4	8	4	8	0	7	2	5	11
11	*Glomerularia*	5	39	28	15	5	2	1	3	4
12	*Helminthosporium*	3	1	0	0	5	3	0	2	0
13	*Nigrospora*	3	9	2	5	18	0	5	5	16
14	*Spadicoides*	7	6	0	0	0	1	0	2	11
15	*Torula*	0	0	2	7	2	0	1	2	2
16	*Ovulariopsis*	0	0	1	0	0	0	0	0	0
17	*Papulospora*	0	4	0	1	3	0	2	2	0
18	*Pestalotia*	0	4	0	0	0	0	0	0	0
19	*Pithomyces*	0	0	1	1	2	0	0	3	0
20	Unldentified Fungal Spores	1	5	2	1	1	1	0	1	28
21	Location total	36	91	56	59	54	28	31	43	98
22	Location %	7.3%	18.4%	11.3%	11.9%	10.9%	5.7%	6.3%	8.7%	198%
23	Monthly total/%	183/36.9%			141/28.4%			172/34.7%		

L1= Location 1; L2= Location 2; L3= Location 3

Their abundance is attributed to the abundance of the source plants within the study area. Poaceae family constitutes the majority of the vegetation around the study area and occurred throughout the sampling period. According to Njokuocha (2006), Poaceae pollen grains from the grass family are the major contributor to the atmospheric pollen content of Nsukka as well as other Southeastern States. The pollen grains from Amarathaceae family which consist of wind pollinated plant species also produce copious quantities of pollen grains. The pollen grains are usually small, light, dry and buoyant. These features enable them to be transported easily by wind (Njokuocha and Osayi, 2005). Their large-scale production thus contributed to their abundance in the atmosphere of the study area. Generally, pollen grains from these families (Poaceae and Amaranthaceae) which are from anemophilous plants are among the major causes of pollen allergies. Burge and Rogers (2008) reported that air borne pollen grains and spores are the major cause of various allergic complaints such as hay fever, eczema and asthma. According to Singh and Rawat (2000), they are easily inhaled, which makes them come in contact with the sensitive nasal passages. The fungal spores were also relatively present.

The study of the air borne fungal spores is important because many of them are important plant pathogens and can cause respiratory and allergic diseases in humans. The attributed to the prevalence of wet period which favors the growth and sporulation of fungi. Spores of *Alternaria* sp., *Dreschlera*, *Helminthosporium*, *Nigrospora* and so on recorded in the study were among the invasive airborne fungal spores reported by Essien *et al*. (2013) to be the cause of allergies such as rhinitis, pollinosis and asthmatic attack as well as respiratory tract infections. Pathologically, these fungi species are also known to be involved in many plant diseases that affect both agricultural crops and wild plants in Nsukka and many other places (Njokuocha, 2006). According to Onyeke *et al*. (2003) and Konopinska (2004), diseases such as leaf blight and spots, purple blotch, damping-off and scab are caused by species of *Alternaria, Dreschlera* and *Helminthosporium*. *Alternaria* sp. is also the cause of cassava blight disease. Maize ear rot disease is caused by *Nigrospora* species (Gxasheka *et al*., 2015). It has also been reported that *Nigrospora* can induce eye and skin infection in humans (Ananya *et al*., 2014).

Conclusion

Pollen, spores and other bio-particles are periodically released and distributed in the atmosphere: their presence, abundance or absence play major roles in the spread of human allergic reactions and plant diseases. The results of this study have showed that the atmosphere of the study area contains lots of airborne pollen and fungal spores even in the rainy season though not in amount comparable to that observed during the dry season. These palynomorphs have been found to be the cause of many allergic conditions including asthma and various diseases affecting humans and plants. Therefore, individuals sensitive to the presence of these allergens in the atmosphere should be mindful of the risk of exposure to these particles.

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