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Airborne pollen grains in Nsukka, Nigeria

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Abstract

A study of the airborne pollen grains in Nsukka, Nigeria, has been carried out at two different sampling heights (1.8 m and 15 m) from February 1993 to January 1994. Twenty-six plant families (40 genera) were identified at the lower sampling height, whilst thirty-eight families (58 genera) were identified at the height of 15 m. A total of nine and eighteen fern spore types were observed at 1.80 m and 15 m, respectively. The quantitative results indicate that the number of pollen observed at 15 m sampling height was statistically different ($p < 0.05$) from that observed at the height of 1.80 m. The analysis of airborne pollen grains indicates three different periods: (1) dry season, (2) rainy season, and (3) late rainy season to early dry season/Harmattan. The highest pollen abundance was recorded during the late rainy season – early dry season/Harmattan followed by that of the dry season. The predominant pollen grains and fern spores trapped at both heights include Poaceae, *Casuarina equisetifolia*, *Milicia excelsa*, *Elaeis guineensis*, *Celtis integrifolia*, *Alchornea cordifolia*, *Amaranthaceae*/Chenopodiaceae, Combretaceae/Melastomataceae, *Nephrolepis biserrata*, *Thelypteris totta*, and *Dryopteris* spp.

Daily observations of the airborne pollen indicate that pollen grains and fern spores are suspended in air turbulence where they are transported over varied distances away from their sources to other areas of the same or different ecological characteristics (Bringfelt et al. 1982). The quantity and variety of airborne pollen grains and fern spores that are trapped at any given period represent an extremely small fraction of the pollen produced at the source areas (Moore & Webb, 1978). Despite this limitation, airborne pollen and fern spores have proved to be extremely relevant in the evaluation of the vegetation characteristics of the study areas, understanding of the flowering periodicity, and in developing a functional model for predicting pollen concentrations in the atmosphere (Andersen, 1980; Chen & Huang, 1980; Lyon et al. 1984; Reddi & Reddi, 1985; Jato et al. 2002).

The dispersal of released pollen grains is influenced by the aerodynamic properties of the pollen and meteorological factors (Jato et al. 2002; Burge, 2002) and in particular, the magnitude of air turbulence which varies according to changes in air

temperature through out the day (Bringfelt et al. 1982; Reddi & Reddi, 1985).

The earlier studies of airborne pollen in south-eastern Nigeria have been limited to short time records of 3–6 months of duration (Agwu & Osibe, 1992; Agwu, 1997, 2001). The present study was carried out over a period of twelve months. The objectives of the study were to ascertain (a) the atmospheric pollen concentration, (b) the vertical distribution of airborne pollen grains, and (c) the seasonal abundance of airborne pollen grains in Nsukka, south-eastern Nigeria (Fig. 1).

The study area

The study was conducted in Nsukka, a suburban town located at an elevation of 419.4 m a.s.l. (6°30' to 7°00'N; 7°10' to 7°10'E; Fig. 1). Anambra plains bound the town on the east and Udi highlands on the south-west. The area belongs to the humid tropical region with average monthly temperature fluctuating between 24°C and 29°C. The mean annual rainfall varies from 786 mm to 2098.2 mm (Fig. 2). The climate is influenced by two major

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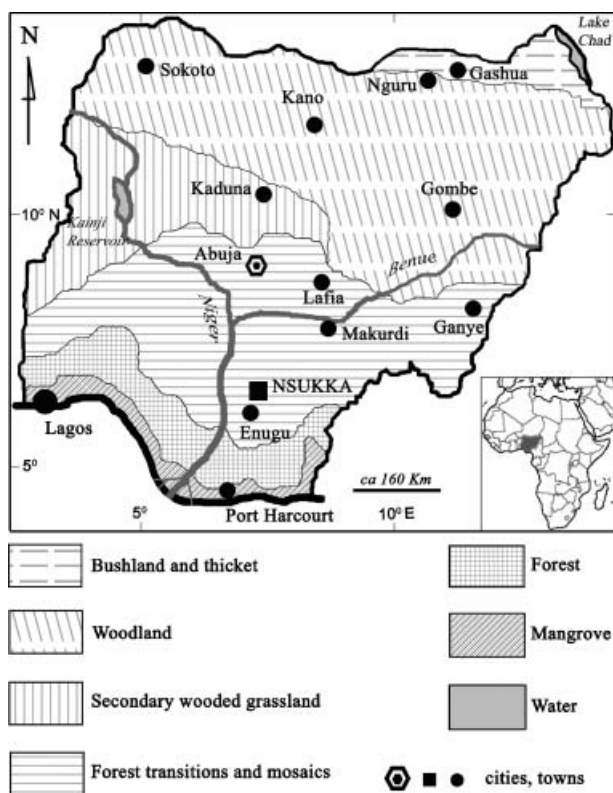


Figure 1. Vegetation map of Nigeria.

seasons, the rainy season (May–October) and the dry season (November–April). The cool dry Harmattan winds (north-east trades) usually dominate from December to early February. The vegetation is a Mosaic of lowland rainforest and

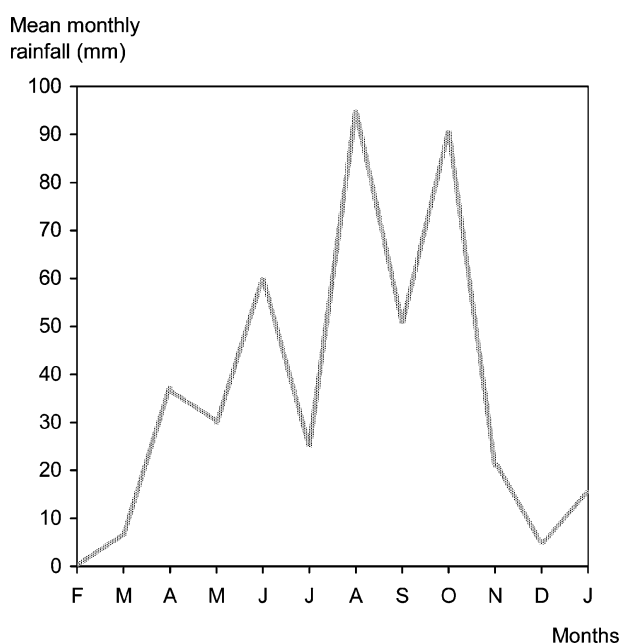


Figure 2. Mean monthly rainfall (February 1993–January 1994).

secondary grassland (Ofomata, 1975; White, 1983; Agwu, 1997).

The vegetation of Nsukka plateau is divided into five sub-types: (i) Grasslands, (ii) Farmlands on derived savanna, (iii) Mosaic farmland/oil palm forests, (iv) Wooded shrub grasslands/woodland and (v) Mature nature forests. The grasslands which dominate the hilly escarpments are characterized by *Andropogon tectorum*, *Antheophora ampulacea*, *Imperata cylindrica*, *Pennisetum purpureum* and *Hyparrhenia barteri* (Agwu, 1997).

The farmlands which also support grasses are growing crops, such as *Manihot esculenta*, *Cajanus cajan*, *Colocasia esculenta*, *Voandzeia subterranean*. The associated shrubs include *Rauvolfia vomitoria*, *Senna hirsuta*, and *S. alata*, while trees include *Parkia biglobosa*, *Daniellia oliveri*, and *Lophira lanceolata*.

The mosaic farmland/oil palm forests contain not only the type of grasses and shrubs growing in grasslands and farmland vegetations, but also trees, such as *Elaeis guineensis*, *Iringia gabonensis*, *Treculia africana* and *Pentaclethra macrophylla*. Herbaceous climbers which include *Luffa aegyptiaca*, *Paullinia pinnata*, and *Ipomoea involucreta* are locally abundant (Agwu, 1997). The wooded shrub grasslands/woodland vegetation is associated with grasses and shrubs such as *Protea madiensis*, *Baphia pubescens*, *Lannea microcarpa* and *Hymenocardia acida*, and trees (e.g. *Prosopis africana*, *Syzygium guineense*, *Vitex doniana* and *Celtis integrifolia*).

The mature natural forests which are relics of tropical lowland rainforest are found in isolated and protected areas. Characteristic tree species include *Brachystegia eurycoma*, *Canarium schweinfurthii*, *Dracaena arborea*, *D. mannii* and among shrubs, herbs and climbers are *Sphenocentrum jollyanum*, *Cissus quadrangularis*, *Napoleona imperialis*, *Harungana madagascariensis* and *Voacanga africana* (Agwu, 1997).

In the University campus and the surrounding villages flourish with introduced plants, such as *Gmelina arborea*, *Casuarina equisetifolia*, *Mangifera indica*, *Anacardium occidentale*, *Terminalia catappa*, and *Senna italica*. Growing among these trees are grasses and weeds that thrive amongst the trees (*Aspilia africana*, *Vernonia pretottii*, *Emilia sonchifolia* and *Argeratum conyzoides*).

Material and methods

This investigation was conducted with two AGWU M6-5 passive pollen samplers (Agwu, 1988, 1997). The sampler has a cylindrical casing with 84 orifices (0.28 cm in diameter) at the upper part of the

column and has a volume of about 123.2 cm³ (Fig. 3).

The samplers were mounted at 15 m and 1.8 m heights. The sampling positions were chosen at locations that have free flow of air and the absence of obstructions. The samplers were located at about 500 m apart from each other because of the lack of a good mounting position free from obstruction and vandalism closer by. Both sampling positions are located in areas of similar floristic composition.

In the preparation of the traps, a transparent tape (3 cm × 2 cm) was fixed onto standard microscopic slide using two narrow strips of double-faced adhesive tape. The upper surface of the transparent tape was smeared with white Vaseline. The smeared slide was transferred to each of the sampler, exposed for seven days and replaced with a new slide weekly for a period of 52 weeks at each location (February 1993 to January 1994).

The exposed transparent tape was detached from the sampler after seven days exposure, placed on a clean microscopic slide with the collecting face down and the cover slip was mounted with gevatol (mounted area of 6 cm²). Each was placed then face down in a slide tray for two weeks before microscopic examination ("KYOWA" standard microscope, ×400 magnification). The pollen identification was based on information in APLF (1974), Ybert (1979), Bonnefille and Riollot (1980), and Agwu & Ahize (1987) and on the reference collections of recent pollen grains of Nigerian flora stored in the Department of Botany at University of Nigeria in Nsukka.

Student's *t* Test was used for the statistical analysis.

Results and discussion

Pollen from 53 genera belonging to 38 plant families were identified from samples collected at the 15 m height, and a total of 40 pollen types from 26 families were observed from the samples at the 1.8 m (Table I). The diversity and abundance of plant families and genera represented in the air samples corresponded to the rich flora in the study area. Despite the entomophilous nature of most plants their pollen were found in the samples supporting the findings of Khandelwal (1988). The number of fern spores was higher at the 15 meters sampling height than at the lower sampling level (Table I). The greater number of pollen grains and fern spores sampled at 15 m on a flat roof top during the peak season suggests long distance transport, larger source area, better mixing and lack of obstruction from trees and buildings. Bringfelt et al. (1982), Gregory (1973) and Reddi and Reddi (1985) have reported similar type of findings.



Figure 3. Agwu M6-5 pollen sampler.

Nephrolepis biserrata, *Thelypteris totta*, *Asplenium* and *Dryopteris* were the most common fern spores recorded. At 15 m sampling height the pollen concentration increased for Combretaceae/Melastomataceae, *Alchornea cordifolia*, *Hymenocardia acida*, *Milicia excelsa*, *Celtis integrifolia*, *Elaeis guineensis* and Poaceae (grasses), whereas more pollen of Asteraceae, *Casuarina equisetifolia*, *Irvingia gabonensis* and Cyperaceae were recorded at the 1.80 m sampling height. The differences observed in the abundance of pollen have been attributed to the variations in aerodynamic limitations of the composite pollen grains and to the geographical distribution of the vegetation sources, wind direction and efficiency relative to the locations of the samplers (Khandelwal, 1988; Dupont & Agwu, 1991; Jato et al. 2002).

There was a significant difference ($p < 0.05$) in the pollen concentrations recorded at sampling heights of 15 m and 1.80 m. This difference is suggested to depend on the long distance transported pollen and the greater contribution of pollen of anemophilous

Table I. Airborne pollen grains and fern spores observed in Nsukka, Nigeria (February 1993–January 1994).

PLANT TAXA	FEB		MAR		APR		MAY		JUN		JUL		AUG		SEPT		OCT		NOV		DEC		JAN	
	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2
<i>Justicia coerulea</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16
Amaranth./	12	10	10	7	1	3	5	12	1	2	1	3	14	1	4	1	5	5	6	5	6	11	14	18
Chenopod.																								
<i>Cissus</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Mangifera indica</i>	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Elaeis Guineensis</i>	22	72	262	68	54	18	3	29	6	5	2	9	6	5	8	33	41	117	42	106	143	278	80	164
<i>Aristolochia ridicula</i>	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Asteraceae	4	0	0	0	1	6	0	0	0	0	1	1	0	1	1	1	8	2	8	3	12	3	9	3
<i>Newbouldia laevis</i>	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Ceiba pentandra</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
<i>Heliotropium</i>	2	1	2	0	0	3	0	0	0	0	0	0	0	0	0	0	0	1	1	1	7	1	0	0
somalense																								
<i>Trichodesma</i>	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
zyeylanicum																								
<i>Burmania</i>	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Cassia italica</i>	0	1	0	1	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
<i>Cassia mimosoides</i>	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
<i>Crotolaria</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
<i>Berlinia grandifolia</i>	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Poiciana regia</i>	0	0	0	6	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Cadaba tomentosa</i>	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Capparis</i>	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Carica papaya</i>	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Casurina</i>	12	10	26	7	114	8	273	18	117	7	473	117	192	38	942	857	146	105	65	57	19	76	338	143
equisetifolia																								
<i>Cochlospermum</i>	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Combret./	3	2	64	18	4	9	1	10	2	0	0	1	0	1	0	1	0	2	9	84	19	11	7	9
Melastomat.																								
<i>Anelama setiferum</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Connaraceae	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Cucumis dispachus</i>	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Cyperus</i>	7	8	6	6	2	2	34	8	7	4	9	4	3	3	3	8	16	10	0	2	1	6	2	1
<i>Dioscorea</i>	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	3
<i>Alchornea cordifolia</i>	19	20	18	51	8	15	1	16	5	1	0	3	0	1	0	1	4	20	44	118	13	7	55	82
<i>Antidesma</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	4	0	0
membranaccum																								
<i>Bridelia feruginea</i>	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Euphorbia</i>	0	1	0	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Hymenocardia acida</i>	6	9	1	0	1	0	9	17	3	37	0	0	0	0	1	5	0	3	1	0	8	22	8	6
<i>Phyllanthus</i>	1	1	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2	5	0	0	0	0	0
<i>Jatropha curcas</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
<i>Tragia hildebrandtii</i>	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Mallotus</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
<i>Irvingia gabonensis</i>	90	1	0	1	6	13	0	22	0	0	0	0	0	0	7	0	0	0	3	6	4	3	0	3
<i>Hyptis pectinata</i>	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Gloriosa superba</i>	1	0	0	2	0	0	1	0	0	0	1	0	0	0	0	0	2	0	1	1	1	3	9	
Malvaceae	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Azadiracta indica</i>	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
<i>Cocculus</i>	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Acacia</i>	1	4	2	3	2	0	0	4	0	0	0	2	0	0	0	0	0	0	1	0	0	3	0	0
<i>Mimosa pygra</i>	4	17	0	0	0	0	2	0	0	0	0	0	0	1	0	0	0	10	8	18	28	3	4	
<i>Antiaris africana</i>	0	3	2	0	0		2	6	0	0	0	2	0	0	0	0	0	0	3	0	0	0	0	0
<i>Bosqueia angolensis</i>	1	0	2	8	0	0	1	0	0	3	1	0	0	0	1	1	1	4	8	3	8	3	2	5
<i>Milicia excelsa</i>	102	598	72	147	20	8	0	5	0	0	0	0	0	0	4	3	2	9	49	92	27	22	33	127
<i>Ficus</i>	29	2	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Morus</i> – type	4	0	2	5	0	0	2	0	3	0	2	3	1	1	0	0	2	6	4	3	0	4	0	2
<i>Myrianthus</i>	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
<i>Syphosyce</i>	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	2	0	1	0	
<i>Treculia africana</i>	1	18	8	2	0	30	16	0	5	1	0	1	0	1	0	9	7	9	4	6	0	0	0	0
<i>Craterogyne</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
Moraceae – type	0	1	1	8	0	0	0	0	2	0	0	0	7	0	0	0	1	0	0	4	0	0	0	0
<i>Pycnanthus</i>	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	34	0	0	0	0

Table 1. (Continued.)

HEIGHT PLANT TAXA	FEB		MAR		APR		MAY		JUN		JUL		AUG		SEPT		OCT		NOV		DEC		JAN	
	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2
<i>Syzygium guineense</i>	0	1	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	3
<i>Lophira lanceolata</i>	0	3	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Olax</i>	0	0	11	6	4	2	0	0	0	0	2	0	0	0	0	0	0	3	0	2	4	4	1	1
<i>Pterocarpus</i>	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
<i>Sesbenia</i>	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Crotolaria</i>	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Pinus sylvestris</i>	0	1	0	1	0	1	0	0	0	0	1	0	0	0	3	0	1	1	0	2	2	0	7	1
<i>Lasiodiscus mildbradii</i>	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Canthium</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
<i>Mussaendra</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
<i>Nauclea latifolia</i>	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
<i>Virecta multiflora</i>	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Citrus</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
<i>Fagara zanthoxyloides</i>	0	0	1	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	25	51	14	25	18	34	3	31	20	68	32	90	30	93	140	227	123	651	311	1319	282	418	36	98
<i>Salvadora</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
<i>Cardiospermum</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
<i>Celtis intergrifolia</i>	8	12	9	3	67	9	138	366	30	100	1	6	0	2	4	7	4	2	4	5	3	2	0	2
<i>Premna resinosa</i> – type	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
<i>Tectonia grandis</i>	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Gmelina arborea</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
<i>Polypodium</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
Varia/Indeterminata	32	45	62	21	8	6	31	15	1	9	2	0	0	0	0	4	23	4	12	53	22	16	12	19
TOTAL POLLEN	391	936	589	418	318	176	524	560	203	241	524	245	253	151	1115	1161	385	960	586	1895	640	932	608	720
FERNS																								
<i>Asplenium</i>	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0	3	3	0	0	0	2
<i>Blechnum</i>	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Cyclosorus</i>	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	3	0	0	0	0
<i>Cystopteris</i>	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
<i>Davallia</i>	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Dryopteris totta</i>	3	0	5	0	5	6	2	8	1	2	0	0	0	0	0	0	0	0	0	0	1	4	0	0
<i>Dictyosporium</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
<i>Microgramma</i>	0	0	0	1	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Nephrolepis biserrata</i>	0	0	0	0	0	0	0	0	0	0	0	1	0	23	0	2	0	0	3	4	0	2	1	0
<i>Neosleotiopsis</i>	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	2	0	0	0	0	0	0
<i>Hypolepis</i>	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Lonchitis</i>	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Phymatodes</i>	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Pteris</i>	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0
<i>Thelypteris</i>	0	5	0	0	0	0	0	0	1	1	0	1	0	0	2	1	0	6	0	1	0	3	0	1
<i>Oleandra</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
<i>Elaphoglossum</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
<i>Sternodia</i>	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fern spores	18	65	6	5	5	4	0	1	0	0	1	5	0	2	0	10	2	7	4	4	0	0	1	6
TOTAL FERNS SPORES	22	72	11	8	10	14	3	10	7	7	1	7	0	26	4	14	2	17	10	16	2	10	3	9
TOTAL POLLEN & SPORES	413	1008	600	426	328	190	527	570	210	248	525	252	253	177	1119	1175	387	977	596	1911	642	942	611	729

plant species that produce pollen grains with good aerodynamic properties (cf. Chakraborty et al. 2001; Mishra, Singh & Oommachan, 2002). Pollen observed in the samples from 1.8 m sampling height

suggests that the herbaceous plants, their possible proximity and greater concentration at a lower sampling height contributed to the greater pollen concentrations of some species (Chakraborty et al.

1998, 2001; Mishra et al. 2002). The number of grass pollen was higher trapped at the sampling height of 15 m during the late rainy season – early dry season/Harmattan (September–December) than during the other seasons of the year. These high pollen numbers at the higher level were probably due to the large quantity of pollen released by the dominant grass community that achieves maturity and anthesis at this period around Nsukka town. The NE wind transports additional load of pollen grains of grasses from the northern extension of the mosaic of lowland rainforest and secondary grassland as well as from the southern and northern Guinea Savanna into the study area.

The period of maximum pollen contribution of *Casuarina equisetifolia* (January, July, and September) to the airborne pollen grains corresponds to the flowering periods in January, May, and September. Also, that of *Milicia excelsa* (February and March) falls within the flowering period of the plant (Keay et al. 1964; Fig. 7). The monthly pollen concentrations showed three distinctly different periods: (1) Dry season (January–April); (2) Rainy season (May–August); (3) Late rainy season – Early dry season/Harmattan (Fig. 8). This trend was especially shown in the recorded pollen concentrations of *Elaeis guineensis* (Fig. 4) and *Alchornea cordifolia* (Fig. 5).

Elaeis guineensis showed a gradual decline in pollen abundance from January–February after which it subsequently increased reaching a peak in March, particularly at the height of 1.80 m. From May–August there was a low pollen count that gradually

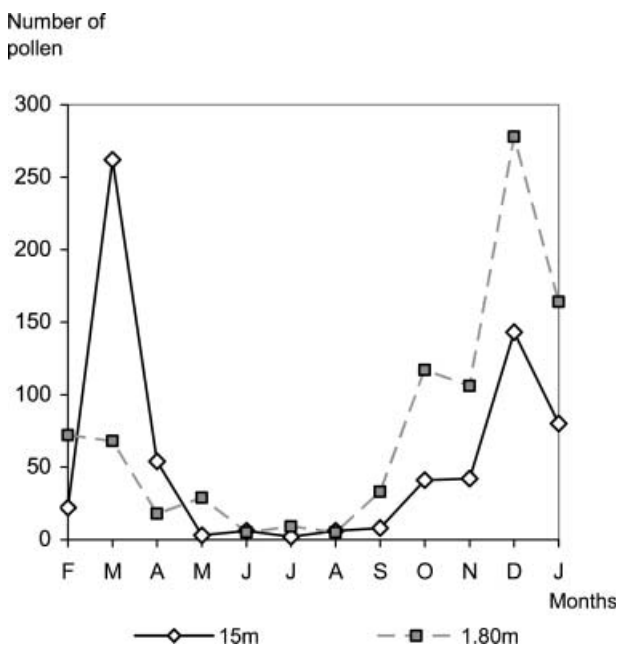


Figure 4. Seasonal variation of *Elaeis guineensis* pollen grains observed at different sampling heights.

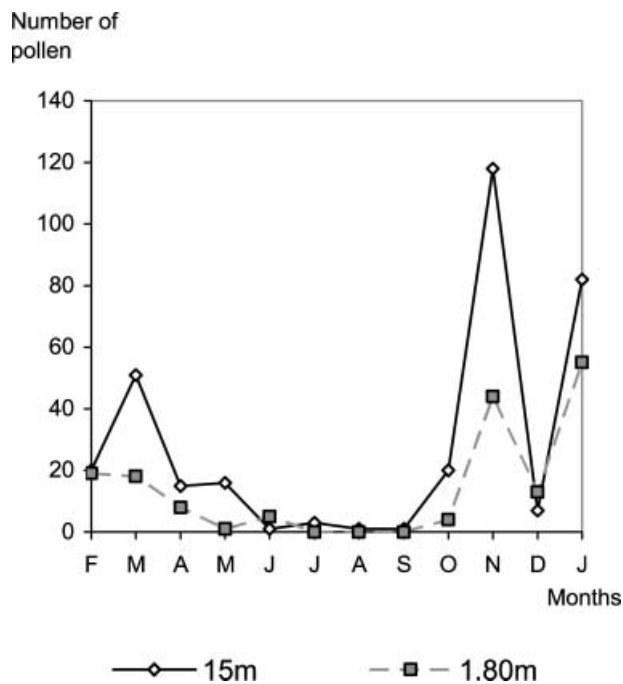


Figure 5. Seasonal variation of *Alchornea cordifolia* pollen grains observed at different sampling heights.

increased from September reaching a peak in December. This trend was also shown in *Alchornea cordifolia* pollen counts (Fig. 5). However, the pollen concentrations were low in December. Poaceae, a major contributor to the atmospheric pollen content of Nsukka was observed in low quantities from January to August and then gradually increasing reaching its peak in November (Fig. 6). The decrease in Poaceae pollen concentration from January to March is related to the increased annual bush fires caused by farmers in Nsukka destroying the grass vegetation (Agwu & Osibe, 1992; Agwu,

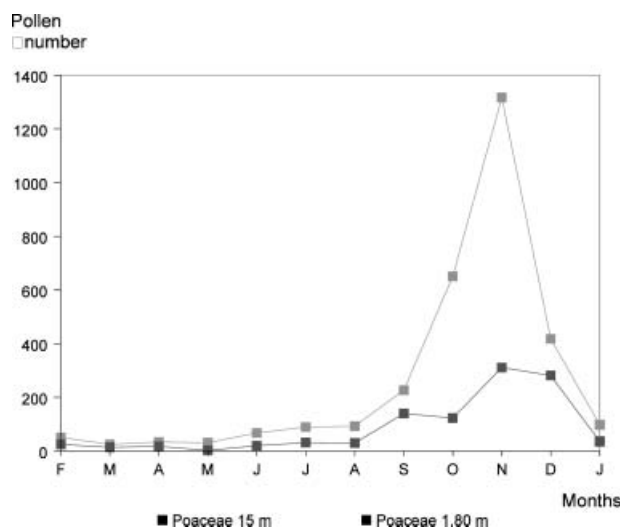


Figure 6. Seasonal variation of grass (Poaceae) pollen grains observed at different sampling heights.

1997). The increased bush fires are also supported by the large quantity of charred grass cuticle and other plant particles observed in the air samples during this period (Table I).

The highest numbers of pollen grains were observed late rainy season – early dry season/Harmattan (September to December), while the lowest concentrations recorded during the rainy season (May to August). Pollen transported by the NE wind (Harmattan winds) in addition to the main flowering season of most trees, shrubs and wild herbaceous plants of the savanna probably contributed to the pollen concentrations in the late rainy season – early dry season/Harmattan. Most of the pollen grains trapped in the study were released from local sources. The origin of *Berlinia grandiflora*, *Lophira lanceolata*, and *Celtis integrifolia* pollen grains is probably farther away from the sampling sites, since the plants are not growing in the investigated area. Some of the Combretaceae/Melastomataceae, *Alchornea cordifolia* and especially Poaceae pollen were most probably transported by long distance from the northern extension of the mosaic of lowland rainforest and secondary grassland of the southern and northern Guinea Savanna which have similar vegetation to Nsukka (Fig. 1).

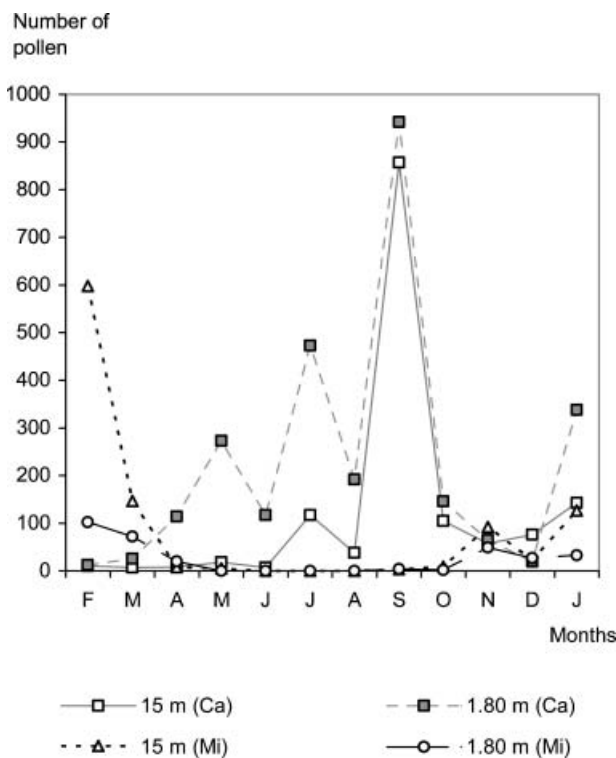


Figure 7. Seasonal variation of *Casuarina equisetifolia* (Ca) and *Milicia excelsa* (Mi) pollen grains observed at different sampling heights.

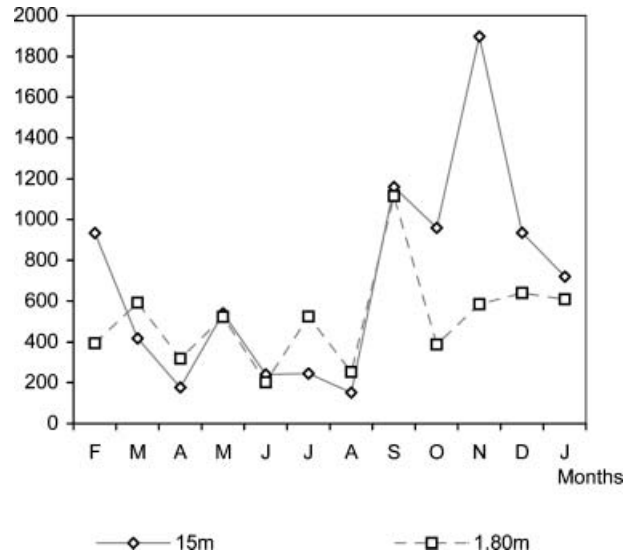


Figure 8. Monthly pollen concentration at the sampling heights of 15 m and 1.80 m.

Conclusions

The results indicate that in Nsukka (1) there are differences in the pollen concentration at various source heights; (2) there are three periods of varying pollen abundance, and (3) the period of highest pollen concentration is the late rainy – early dry season/Harmattan (September to December), whilst the low pollen season is during the rainy period (May to August).

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