Journal of Ecology and the Natural Environment Vol. 3(14), pp. 455-460, 26 November, 2011
Available online at http://www.academicjournals.org/jene
DOI: 10.5897/JENE11.082
ISSN 2006 - 9847©2011 Academic Journals

Full Length Research Paper

Palynological investigation of haze dust in Ayetoro-Itele Ota, Southwest Nigeria

P. A. Adeonipekun* and M. John

Department of Botany, Faculty of Science, University of Lagos, Nigeria.

Accepted 24 October, 2011

The biological contents of the March 2010 hazy dust in Nigeria deserve verification due to the attendant panic it brought to the public. 3 g of dust deposited on the car bonnet of one of the authors was treated chemo-palynologically and microscopic study of the residue was carried out. The study reveals that the dust was rich in pollen grains, fungal spores and hyphae. No pteridophyte spore was recovered. High proportion of diatoms almost doubling that of the sporomorphs was recorded. Savanna and derived savanna pollen grains and the Sahara desert freshwater diatoms recovered indicate that the dust was still the harmattan borne by the Northeast Trade winds though coming heavily and lately in March instead of the traditional January. This indicates a delay in the northward movement of the Inter Tropical Discontinuity (ITD) with the consequential abnormal hazy atmosphere. Some typical Sudan and Sahel vegetations' pollen were not recovered inspite of the dust crossing over them, perhaps due to being dropped along the way or March not being their flowering periods. Pollen of *Vitex* cf. *doniana* dominates the palynoflora along with *Isoberlinia doka* which might be candidate culprits for clinical conditions in the experimental area.

Key words: Saharan dust, palynoflora, diatoms, intertropical discontinuity.

INTRODUCTION

A strange dust resulting from hazy atmosphere throughout the month of March, 2010 in Nigeria created panic among citizens. That the harmattan brings dust from the Sahara to the southern part of the country and even across the Atlantic into the Caribbean is well known and researched. However, the magnitude of this dust and its timing as witnessed in Nigeria in the strange March dust episode and the attendant public concern aroused the authors' interest in its palynological contents. Though the National Aeronautics and Space Administration (NASA) of United States of America, Nigeria Meteorological Agency (NIMET) and other national science-based research institutions adduced the strange dust condition to consequences of global warming, the need to further ascertain the palynological contents of the dust cannot be over-emphasized.

*Corresponding author. E-mail: aadeonipekun@unilag.edu.ng, p1adeonipekun@yahoo.com.

The few aeropalynological studies carried out so far in Nigeria have come from Nsukka, southeast Nigeria. They are the works of Agwu and Osibe (1992), Agwu (2001), Agwu et al. (2004), Njokuocha and Osayi (2005), and Njokuocha (2006). These works have shown the richness of the aerospora and the common pollen and spores as well as fungi in the air of the south-eastern Nigeria. Chief components of their recovered palynomorphs include *Poaceae, Elaies guineensis, Combretum/* Melastomaceae, *Alchornea cordifolia,* Amaranth/ Chenopods*, Asteraceae* and Pteridophytes spores as well as diatom frustules. Njokuacha (2006) affirmed the contributions of both allochthonous and authochthonous sources for the recovered palynomorphs. With respect to the southwest of Nigeria, Adekanmbi and Ogundipe (2010) remains the only published work on its aeropalynology known to the authors. In their work, they revealed the significance of Poaceae, Asteraceae, Mimosaceae, Aracaceae and pteridophyte spores as well as Euphorbiaceae in their collection within the University of Lagos campus, Akoka Lagos. Other research works

though not involving palynology but centered on the dust of southern Nigeria are those of Adetunji et al. (1979) and Adedokun et al. (1989). Adetunji et al. (1979) and Adedokun et al. (1989) worked on the mineralogy of the harmattan dust in Nigeria. They concluded a Saharan source for this dust and indicated its significance on the agriculture, health and micro-climate of West Africa and even beyond. He et al. (2007) also worked on the harmattan dust in Ghana. They concluded that local dust also contributed to the hazy atmosphere though the Saharan source was higher since the pH of the dust studied was significantly higher than that of the local soils.

Romero et al. (1999) reported that deposition of fresh water diatoms and phytoliths in the eastern and western equatorial Atlantic regions varied with seasonal changes in Saharan dust transport controlled by the direction of the major wind systems, seasonal precipitation patterns and geographical extension of dust plumes across the Atlantic. Delgado et al. (2010) further confirmed the significance of the Northeast trade winds in the supply of biogenic substances in the aerosol of the high mountain of Tenerife Canary Islands. They showed that the dust from the North African desert contains freshwater diatoms of *Aulacosiera* genus. From all the cited works on the dust events of Africa, it is clear that the northeast Trade winds have a significant impact on the atmospheric components in Nigeria and thus influence the direction and composition of the local air currents as it relates to palynological contents.

This work is the first palynological work known to the authors on the Saharan dust events in Nigeria, which was occasioned by the strange dust experienced in Nigeria in March 2010. The authors hope to reveal the pollen and spores and other palynological components present in the collected dust during this strange dust episode; so as to infer the source. Inferences regarding candidate palynological allergens and their proportions during the hazy condition can be made from this study.

MATERIALS AND METHODS

The experimental site is about 200 m from the lush gallery forest along Adanmo River separating Lagos (Ayobo) and Ogun (Aiyetoro-Itele) states in the southern periphery of Ado-Odo Ota Local Government Authority (Figure 1).

Climate

The experimental site is located in AdoOdo Ota Local Government Area, Ogun State within the moderately hot, humid tropical southwestern Nigeria. Two distinct seasons: the rainy season - March/April to October/November and the dry season - October/November to March/April are characteristic. Mean annual rainfall varies from 128 cm in the southern part to 105 cm in the northern areas. The relative position of inter-tropical discontinuity (ITD) at a particular period of the year determines the climate of West Africa to which Nigeria belongs. In January, the ITD is in its southernmost extent around latitude 5°N while by July, it is in the far north around latitude 15°N (Sowunmi, 1986). The south-westerly winds dominate the area between April and October bringing heavy rains when the ITD is in the far north. As the ITD moves down towards latitude 5°N, the north-easterlies dominate mainly between November and February bringing dry dusts and harmattan haze in December and January.

Vegetation

Ogun State straddles three vegetation types: Tropical rainforest, Guinea savanna and the Mangrove swamp (Figure 1).

Experimental area vegetation reconnaissance

A reconnaissance of the experimental site (50 m radius) shows that the following plants grew abundantly during the month of March 2010 when the sample used for this work was collected: *Panicum maximum, Elusine indica, Imperata cylindrica, Chromolaena odorata, Tridax procumbens, Mariscus alternifolious, Ipomoae involucrata, Ipomoea* spp. *Boehavia diffusa, Euphorbia hirta, Euphorbia heterophylla, Phyllantus amarus, Mimosa pudica, Commelina benghalensis, Gomphrena celosoides* and *Vernonia cinerea.* Plants with fair occurrence*: Carica papaya, Mangifera indica, Psidium guajava, Hyptis suaveolens, Talinium trangulare, Manihot esculenta, Portulaca oleracea, Anana comosus* (Pineapple), *Vernonia amygdalina* (Bitter leaf*), Nicotiana tobacco* and *Cocos nucifera* (Cocoyam farm*).* Though some of these plants did not flower during this period, it is however important to list them, since they might have flowered earlier before the month of collection and had their pollen deposited in the surrounding of the collection site. With the presence of their pollen in the surrounding, local air currents may blow them into the atmosphere. Among those that flowered during the collection month were *E. hirta, H. suaveolens, N. tobacco, T. procumbens, A. comosus, C. odorata, P. maximum, M. alternifolious, V. cinerea, G. celosoides* and *C. benghalensis.*

Three grams of dust deposited on the car bonnet of one of the authors was collected on the 29th of March, 2010. This car had been parked in the location since the beginning of the month of March as a result of battery failure, hence the dust contains particles of that month. A rainfall rumored to be acidic in composition fell on this car on the 23rd March and this left a milky coloured dust all over the car including the bonnet. Out of curiosity for the palynological contents of this dust, the authors decided to subject it to a palynological investigation.

The collected sample was acetolysed with acetic anhydride and concentrated tetraoxosulphate VI acid (H_2SO_4) in the ratio 9:1 according to Erdtman's (1969) method. Microscopic analysis of 20 µl sub-sample out of the produced residue was carried out with the sub-sample gently poured on a glass slide and covered with cover slip. Two slides were produced and the palynomorphs recovered were identified mostly to a specific level while some were identified only to the family level. Some could not be identified and were therefore regarded as indeterminate. The residue volume was noted (0.1 ml) and a known volume of pure glycerine (0.1 ml) was added in the graduated test-tube. The new volume of the stored residue then became 0.2 ml (200 µl). Total pollen counted from the prepared 20 µl was 125. Since 20 µl residue contains 125 pollen grains, 200 µl of residue will generate 1,250 pollen grains. This means that the 3 g of sediment contains 1,250 pollen grains. Therefore, 1 g of the sediment will contain approximately 417 pollen grains. Photomicrographs of some important pollen grains and fungal elements as well as diatoms recovered were taken (Plate 1)

Attempt was made to use the recovered palynomorphs for making climatic inferences for the period of sample collection. This was done by categorizing the sporomorphs on the basis of their

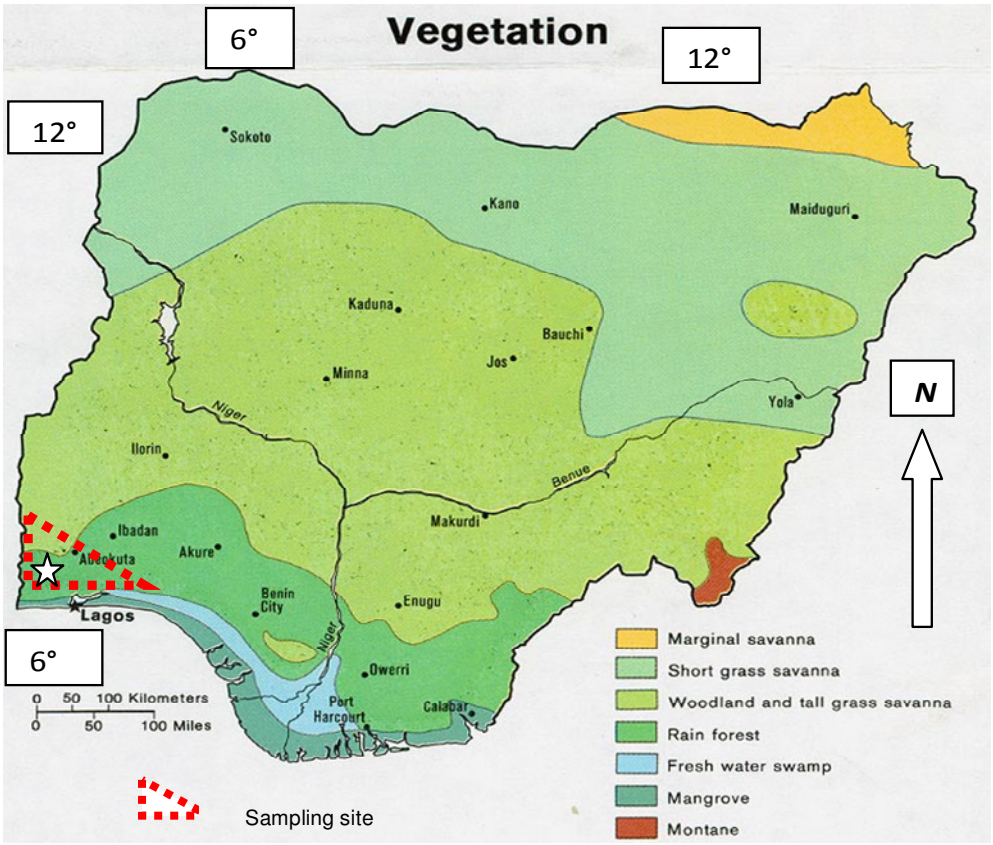

Figure 1. Vegetation map of Nigeria (Ogun State in triangle with sampling site asterisked).

of savanna and open vegetation species in the tropics (Sowunmi, 1986). Therefore, in categorizing the recovered palynomorphs into palynoecological groups, 120 correctly identified pollen grains with known ecological ranges were utilized. Others with uncertain ecological ranges were left out in the categorization. With this climatic consideration, Rainforest, Freshwater, Savanna, and Open vegetation palynoecological groups were made for the identified pollen. Unidentified pollen regarded as indeterminate were kept out of the categorization. The Rainforest and Freshwater groups represent the Wet condition indicators while the Savanna and Open vegetation groups represent the Dry condition indicators. The following plants whose pollen were recovered from the sample made-up the wet condition indicating species: *Khaya* sp., *Citrus* spp. *Combretum*/Melastomaceae, *A. cordifolia* and *E. guineensis* (Rainforest); *Oncocalamus manni, Cyperus* sp. *Tetrocarpus* sp. *Syzygium guineensis,* and *Crudia* sp. (Freshwater) while the dry condition indicating species are *Vitex* cf. *doniana*, *Isoberlinia doka*, *Parinari* spp. (Savanna) and Gramineae, Acanthaceae, Chenopod/ Amaranth, *Borreria* sp. (Open vegetation).

RESULTS

A total of 125 pollen grains, 11 fungal hyphae as well as ten fungal spores were recovered. The total of wet climate indicator palynoecological groups is 42 while that of dry climate indicator groups is 78 (Table 1). *Vitex* cf. *doniana* pollen (50 in number) makes up 41.67% of the palynomorphs recovered (Table 2). The plant that contributed this pollen does not exist in the area of collection on a reconnaissance. It must have come from the Guinea savanna ecological zones. *Parinari* spp. and *I. doka* are other savanna pollens recovered from this sample. Common herbs such as *Cyperus, C. benghalensis, T. procumbens, V. cinerea* and *Ipomoea* spp. around the site were rarely recovered despite the flowering of some of them as mentioned earlier. No single pteridophyte spore was recovered in spite of the Adanmo River being close to the site (200 m away) while diatom species of *Aulacoseira granulata* dominated the preparation with values almost doubling the total number of pollen.

DISCUSSION

The Savanna and derived savanna pollen grains such as *Vitex* cf. *doniana, I. doka* and *Parinari* spp. recovered indicate that the dust was still the harmattan borne Northeast Trade winds though coming lately in March instead of January/February. Their abundance in the sample is an unequivocal evidence that the dusty wind brought them from a far area. None of the works so far

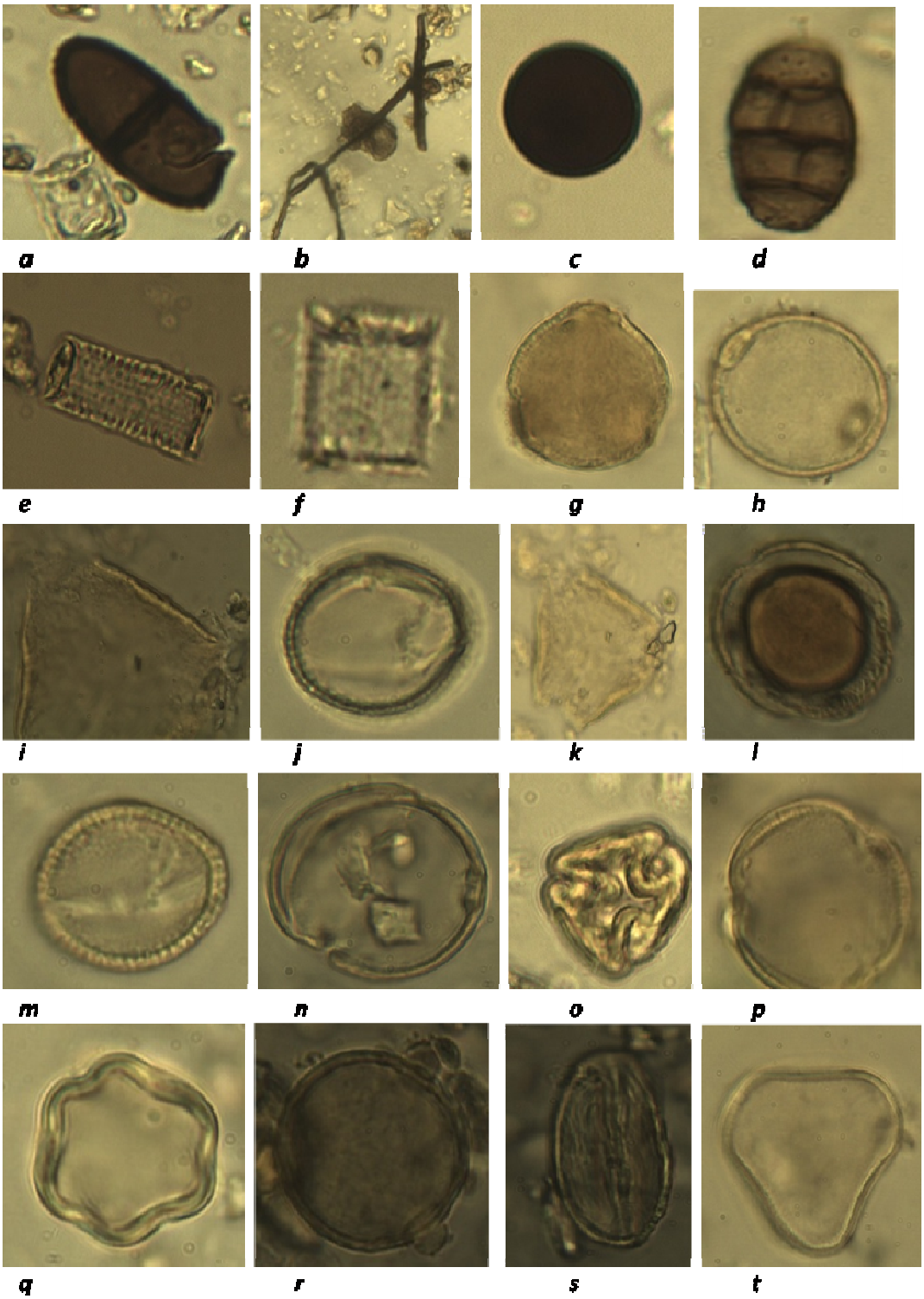

Plate 1. (a, c and d) Fungal spores ×1000; (b) Fungal hyphae, x400; (i and k) *Parinari kerstingi* ×400 and ×1000; (e and f) Diatoms ×1000; (q) *Combretum /Melastomaceae,* ×1000; (h, n and r) *Citrus* spp., ×1000; (g, j, m and p.) *Vitex cf.* doniana, ×1000; (t) *Elaies guineensis*, ×1000: (l and s) *Isoberlinia doka*, ×1000; (o) *Parinari* sp. ×400.

published on the aeropalynology of Southern Nigeria, has this record of abundance of these pollen. Even the works of Njokuocha (2006) that recorded a twelve-month data collection from January to December does not have this abundance in the month of March let alone other dry period months. This may indicate a delay in the up North

Table 1. Proportions of recovered palynomorphs/palynoecological grouping.

Pollen grain	Family	Proportion	Palynoecological group
Acanthaceae	-	1	Open
Amarantheceae	-	1	Open
Alchornea cordifolia	Euphorbiaceae	6	Freshwater
Borreria spp.	Rubiaceae	2	Open
Citrus spp.	Rutaceae	8	Rainforest
Combretum sp.	Combretaceae	4	Rainforest
Cyperus sp.	Cyperaceae	1	Freshwater
Elaeis guineensis	Palmae	4	Rainforest
Gramineae	-	9	Savanna
Isoberlinia cf. *doka*	Caesalpinaceae	8	Savanna
Khaya sp.	Meliaceae	2	Rainforest
Lannea microcarpa	Anacardiaceae	1	Savanna
Parinari kerstingi	Rosaceae	5	Savanna
Parinari sp.	Rosaceae	1	Savanna
Pterocarpus sp.	Papilionaceae	5	Freshwater
Cf .Tetrad pollen	-	1	-
Syzygium guineensis	Myrtaceae	1	Rainforest
Tetrochidium sp.	Euphorbiaceae	10	Freshwater
Oncocalamus manni	Palmae	1	Freshwater
Vitex cf. doniana	Euphorbiaceae	50	Savanna
Triporate pollen	Cf. Rubiaceae	1	-
Indeterminate pollen		3	-
Fungal spores		10	-
Fungal hyphae		11	-

Table 2. Percentage compositions of palynoecological groups

Palynoecological group	Rainforest	Freshwater	Savanna	Open vegetation
Number of pollen grains	19	23	74	4
% Composition	15.83	19.17	61.67	3.33
Climatic inference	Wet condition index (35%)		Dry condition index (65%)	

movement of the ITD with its attendant hazy atmosphere across the country and also an upsurge in the intensity of the winds. What triggered this unusual high intensity is not clear. This event will need to be monitored over a reasonable period of time for an appropriate conclusion.

Of climatic significance however, is the higher proportion of dry climate indicator pollen and absence of humid wet indicator - fern spores - inspite of the location being close to coastal Lagos with high lowland rainforest components. In southernmost Nigeria aeropalynology, proportion of savanna is generally low relative to rainforest and other wet climate indicator pollen (Njokuocha, 2006; Adekanmbi and Ogundipe, 2010). For this 61.67% savanna record, the late harmattan aided strongly the presence of the dry condition indicating pollen. Surprisingly however, other typical Sudan savanna pollen such as *Parkia clappetoniana, Acacia* spp., *Adansonia digitata*, *Balanites* and Sahel Savanna pollen such as *Fadogia, Salix* and *Grewia* were not recovered, despite the winds passing through them. It is likely that the large size of these pollen have precluded their presence in the dust having been dropped along the way before getting to the deposition site or rather the flowering periods did not straddle the collection month. It may also mean that they are not prolific pollen producers. Work has commenced on the pollen productivity of these plants. Dominance by *Vitex* cf. *doniana* and *I. doka* in the collected sample makes them prime suspects for clinical conditions; some hypersensitive persons might have experienced during the hazy period in the experimental area. Research on allergenic pollen in Nigeria is still insipient. However, from this study, these two pollen grains are candidate allergens that need to be further investigated.

The abundance of freshwater diatoms in the studied dust sample cannot be overlooked. It is not unexpected, for Njokuocha and Osayi (2005) and Njokuocha (2006) also recorded diatoms. However, this abundance was enhanced by the up surging winds at this time. This abundant recovery further indicates the dust source to be the Saharan desert dry lakes such as Lake Chad and perhaps an indication of its silica richness, since diatoms bivalves are made up of 80 to 90% of silica (Lloyd, 1997). The revelation from this work has kick-started a twelve month aeropalynological survey of the experimental site currently going on. The results from this one month collection study will be compared with a calendar year and the following year March collection in particular upon completion.

Conclusion

The hazy dust studied contains high proportions of palynomorphs from the Sudan/Guinea and derived savannas as well as lowland rainforest ecozones. Higher proportions of the savanna and open vegetation species than the rainforest and freshwater components point to a Saharan source for the dust that enveloped Nigeria for a whole month. The diatomaceous components of this dust further give credence to the source being the African Saharan desert dry lakes. This confirmed Saharan source means that the ITD relative position in March was where it should be in January, thus indicating a delay since the dust supposed to have come earlier in December to January.

The cause of this delay and sudden appearance needs further investigation probably through monitoring over a reasonable period of time which the next stage of this work is currently investigating. The absence of some other typical Sudan and Sahel savannas' pollen across which the wind travelled suggests that the plants do not flower in March or that their pollen were dropped along the way or that these plants are probably poor pollen producers. Further study on the aeropalynology of the Ota area in other months of the year currently going on, will shed more light on this.

REFERENCES

Adedokun JA, Emofurieta WO, Adedeji OA (1989). Physical, mineralogical and chemical properties of Harmattan dust at Ile-Ife, Nigeria. Theor. Appl. Climatol. 40: 161-169.

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

Adetunji J, Mcgregor J, Ong CK (1979). The Harmattan haze. Weather J., 34: 430-436.

Agwu COC (2001). A study of Niger Delta environment through airborne palynomorphs, Port Harcourt, Nigeria. Palaeoecol. Afr. 27: 191-205.

Agwu COC, Njokuacha RC, Mezue O (2004). The study of airborne pollen and spores circulating at" Head Level" in Nsukka environment. Bio-Research, 2(2):7-14.

Agwu COC, Osibe EE (1992). Airborne palynomorphs of Nsukka during the months of February - April, 1990. Niger. J. Bot., 5:177-185.

Delgado JD, Garcia OE, Diaz AU, Diaz JP, Explosito FJ, Cuevas E, Querol X, Alastuey A, Castillo S (2010). Origin and SEM analysis of aerosols of aerosols in high mountain of Tenerife (Canary Islands). Nat. Sci., 2(10): 1119-1129.

Erdtman G (1969). Handbook of Palynology. Munksgaard, Copenhagen, p.209.February - April, 1990. Nig. J. Bot. 5:177-185.

G. W. Lawson John (ed.) Wiley and Sons Ltd.: 273 – 306.

He C, Breuning-Madsen H, Awadzi TW.(2007). Mineralogy of dust deposited during the harmattan season in Ghana. Danian J. Geogr. 107(1): 9-15.

Lloyd A (1997). Diatomite. Retrieved on 2011/07/07 from *Wikipedia/file:///c:/Diatomaceous_earth.htm*

Njokuocha RC (2006). Airborne pollen grains in Nsukka, Nigeria. *Grana* 45(1): 73 – 80.

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

Romero OE, Lange CB, Swap R, Wefer G (1999). Eolian-transported freshwater diatoms and phytoliths across the equatorial atlantic record: Temporal changes in Saharan dust transport patterns. J Geophys. Res., 104 (C2): 3211-3222.

Sowunmi MA (1986). Change of vegetation with time. In: Plant Ecology in West Africa.