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Palynological analysis of Spider webs from Lagos state, Southwestern, Nigeria

Okwong John Walter[1], Olusola Helen Adekanmbi[2], Linus Bashie Ajikah[3]
[1, 2, 3] Department of Botany, Faculty of Science, University of Lagos, Akoka, Lagos, Nigeria

Abstract
Aeropalynological investigation of the atmosphere of Ijegun in Lagos was carried out from January 2018 to December 2018 using spider webs. These present studies aim to monitor the air quality regarding the aerospora and to know the qualitative & quantitative dispersal of pollen and spores in the atmosphere with the help of spider webs. Webs were collected from nine different locations around the study location for the periods of 12 months. The recovered webs were subjected to standard laboratory procedures using HCl and acetolysis mixture. The January to December microscopic investigation reveals total pollen/spores count of 1,175 belonging to 15 plant families, four fungi families and one algae family. The recovered palynomorphs were grouped as trees (28%), herbs (29%), shrubs (13%), fungi spore (17%), aquatic plants and diatoms recorded (6%) respectively. The predominant pollen grains were those of *Tectona grandis, Irvingia gabonensis, Zea mays, Torula* sp., *Aulacoseira* sp., Poaceae and Fabaceae which were responsible for the highest pollen amounts in the study area. The dominance of fungi spores in these study could be ascribed to the prevailing damp condition around the sampling location. Several pollen grains and fungal spores, reported during the present study are known to be allergenic. The investigation revealed that spider webs act as natural pollen traps, and are useful to know the incidence of allergy-causing pollen.

Keywords: aeropalynology, spider webs, allergy, pollen grains, ijegun, lagos

1. Introduction

The air, without which life cannot exist, contains an array of bioparticles among which pollen grains and spores forms one of the dominant concentrations. Unfortunately, humans inhale the free-floating pollen grains and spores without knowing, leading to hypersensitive reactions also known as allergy. The common symptoms of these allergic reactions include bronchial asthma, atopic dermatitis, rhinoconjunctivitis and a general feeling of malaise, among others. The study of pollen grains and spores in the atmosphere and their eventual dissemination, deposition, and impact on human systems is referred to as aeropalynology [12]. In Nigeria, aeropalynological assessment has been carried out in different part of the country using the gravitational method due to unstable power supply. This study which includes the correlation between pollen data and meteorological parameters [13, 9, 10, 4]. Relationships between airborne pollen load and medical data [5]. Inferences on their health risk periods [55, 13, 10], and investigating dominant palynomorphs types [2, 6, 7, 1, 8, 3]. Natural samplers such as surface soils, leaves and bark, moss and lichen cushions, have been used conventionally in the study of pollen rain & vegetation relationship [14, 17]. Spider webs contain competent natural pollen trap and their study has provided factual data on the modern pollen rain and differential dispersal and deposition of its various entities in a particular geographical area [11, 21]. The period during which a spider leaves its web intact is crucial for survival. Prolonged exposure of a functional web, which increases the chances of catching an insect, pollen and fungi spore is particularly important in the dry season. Several authors have specified that the webs of immature ecribellate orb-weavers are pollen collectors and that the pollen grains adhering to the sticky threads are unintentionally ingested along with the old silk material when the spider lings are recycling their webs. The sticky nature of the pollen grain, flexibility and small pore size of the web and its ability to adhere to a structure for a very long time makes it a reliable natural pollen sampler. Spider webs have also proved to be a useful indicator of environmental chemistry and have applications in cave environmental studies [19]. The aim of this study was to provide information on qualitative and quantitative dispersal of pollen and spores trapped in the spider webs in Ijegun, Southwestern, Nigeria.

2. Materials and Methods

2.1 Study Location

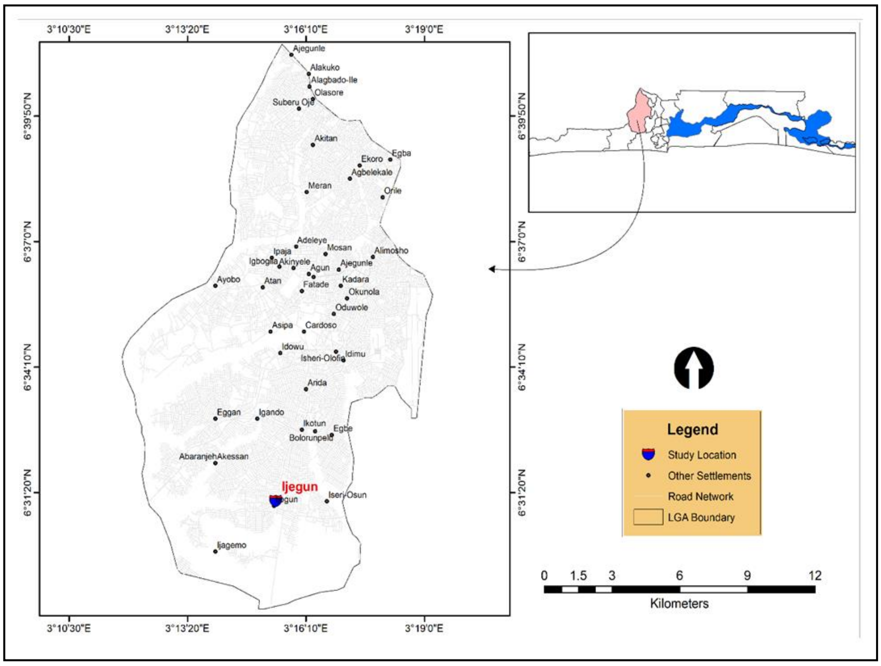


Fig 1: Map showing the sample location at Ijegun community, Lagos, Nigeria

Ijegun is a northern suburban community in Alimosho Local Government Area of Lagos State, Nigeria. It is situated between 6.5190oN lat. and 3.2573oE long. (Fig. 1), bordered in the north and east by Ogun State, in the west by the Republic of Benin and in the south by the Atlantic Ocean. A vegetation reconnaissance of the study site was carried out and the sampling point was determined using a global positioning system. The map of the location was developed by using Arc GIS software.

The vegetation zones consist of the rainforest, mangrove swamp, and freshwater swamp. It is a coastal area which consists of estuaries, low lying tidal flats, sandy barriers, islands, and wetlands. It is characterized by two seasons; the wet (April to October) and the dry (November to March). The wet season is characterized by a double peak of rainfall in June and October due to the prevailing south-westerly wind, accompanied by the northward and southward movement of the Inter-Tropical Convergence Zone. In the dry season, there is a prevailing north-easterly wind that brings with it the dry dust from the Sahara Desert. The mean air temperatures of the wet and dry seasons are 24°C and 34°C respectively.

The present vegetation is a secondary swamp vegetation dominated by *Elaeis guineensis*, *Terminalia catappa*, *Dryopteris* sp., *Cyclosorus afar*, and *Psidium guajava*. Characteristic herbs and shrubs which predominate in the site are *Tridax procumbens*, *Alchornea cordifolia*, *Celosia argentea*, *Ocimum grattisimum*, *Telfaria occidentalis*, *Abelmoschus esculentus*, *Syzygium guineensis*, *Phyllanthus amarus*, *Ageratum conyzoides*, *Amaranthus spinosus*, Poaceae and *Acrostichum aureum*, *Zea mays*, *Boerhavia erecta*, *Sida corymbosa*, *Sida acuta*, *Spigelia anthelmia*, *Centrosema* sp., *Euphorbia hirta*, *Euphorbia heterophylla*, *Euphorbia splendens*, *Acalypha ciliata*, *Commelina benghalensis*, *Synedrella nodiflora*, *Chromolaena odorata*, *Bidens pilosa*, *Potulaca oleracea*, *Talinum triangulare*, *Physalis angulata*, *Fleurya aestuans*, Other taxa present in small quantities *are Gomphrena celosoides*, *Cyperus rotundus*, *Phycus* sp., *Panicum maximum*, *Phyllanthus reticulates*, *Vernonia cinerea*, *Andropogon gayanus*, and *Mariscus alternifolius.*

2.2 Laboratory analysis

Spider webs were collected for a period of twelve months from nine locations within the same community. Spider webs were rolled at the end of the brush and put into suitable plastic vials. One hundred and eight web samples were collected from study sites during the month of January 2018 to December 2018. Upon arrival in the Palynology and palaeobotany Laboratory, each of the sub-sample was weighed and measured in the laboratory. The webs were analyzed according to (Faegri *et al*., 1989). The webs samples were treated with 10% of concentrated hydrochloric acid to dissolve the weaves. The unessential materials in the solution were removed with a sieve i.e. small twigs, fruit, leaves, insect part, etc., and the beaker was washed with distilled water to remove pollen/spore. The samples were washed three times with distilled water to remove the concentrated acid. The residue was mixed with 20 ml of concentrated hydrofluoric acid and kept for 24 hours to remove silica. The mixture was washed and centrifuged thrice to remove the acid, the residue was treated with acetolysis mixture (acetic anhydride and concentrated sulphuric acid in v/v=9:1) to make the sample more translucent. Finally, the acetolyzed samples were kept in 50% glycerine jelly in which two drops were added with a micropipette and mounted on glass slides and a coverslip was placed gently on the residue in a way to prevent the formation of air bubbles. The slide was sealed using a commercial nail lacquer, to make a semi-permanent slide and studied qualitatively using an Olympus light microscope.

Identification of pollen type was achieved with the help of reference slides in the Palynology and Palaeobotany Laboratory, Department of Botany, University of Lagos and published journals [22, 16]. Photomicrography of palynomorphs was done by using a Zeiss Merlin Field emission scanning electron microscope. The recovered palynomorphs were grouped as trees, shrubs, herbs, aquatic plants, fungal spores and algal remains (Fig. 2). Only pollen grains and spores, identified to specific, generic or familial level, were selected to constitute the pollen sum. While the pollen spectrum was constituted from the palynomorphs recovered during the pollen analysis of the spider webs samples. The pollen diagram was constructed using Tilia graph computer software.

3. Results & Discussion

The January to December microscopic investigation reveals total pollen/spores count of 1,175 belonging to 15 plant families, four fungi families and one algae family (Table 1). The herbaceous group was dominant and Fabaceae (8.0%) being the most dominant in these group. Other members of these group include Poaceae (7.2%), *Capsicum frutescence* (5.1%), *Helianthus annus* (5.1%), Tridax procumbens (3%), and *Talinum triangulare* (0.4%). The arboreal group was also dominant and *Tectona grandis* (8.4%), as well as *Irvingia gabonensis* (8%) were recorded in high frequencies. *Trecula africana* (3.3%), *Terminalia catappa* (< 0.5%), *Mangifera indica* (2.4%), *Elaeis guineensis* (3.2%), and *Szygium guineensis* (2.4%) are intermittently represented in the pollen spectra. Zea mays amongst the shrubby elements, is the chief component of the pollen rain and is recorded in high frequency. *Amaranthus* sp. is represented in high values in contrast to *Acacia* sp., and *Ixora parviflora* which are represented in extremely low value. *Typha latifola* (3.9%), and *Alchornea cordifolia* (2.3%), aquatic elements, were encountered moderately. Fungi spores such as *Nigrospora* sp. (0.8%), and *Alternaria* sp. (1.3%) were recorded in low values, while *Torula* sp. (6.0%), *Curvularia* sp. (3.0%), *Helmithosporium* sp. (2.2%), and *Pithomyces* sp. (4.2%), were recovered in appreciable value. The only algal elements recovered was the *Aulacosiera* sp. (6.0%) which is retrieved in high frequency. The recovered palynomorphs were grouped as trees (28%), herbs (29%), shrubs (13%), fungi spore (17%), aquatic plants and diatoms recorded (6%) respectively (Figure 3).

Pollen analysis of spider-web samples from Ijegun reveals the dominance of pollen of trees and herbs, whereas shrubs, as well as fungi spores and algal remains, are feebly represented (Table 1). Hence, the palynoassemblages recovered from the analysis of spider webs do not reflect the actual composition of local vegetation of the study area, so far as the tree taxa are concerned.

Table 1: Showing the frequency composition of palynomorphs recovered from spider webs in Ijegun

S. no	Genus/Species	Family	Jan.	Feb.	Mar.	Apr.	May.	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	%
1.	*Poaceae*	Poaceae	0	2	5	8	12	11	13	8	4	15	5	2	7.2
2.	*Typha latifola*	Typhaceae	1	5	7	9	3	0	0	2	6	4	5	2	3.9
3.	*Amaranthus sp.*	Amaranthaceae	6	5	11	3	3	4	8	6	1	2	1	0	4.2
4.	*Szygium guineensis*	Myrtaceae	0	0	3	7	0	4	5	0	0	0	0	0	2.0
5.	*Tectona grandis*	Lamiaceae	0	11	23	50	0	0	15	0	0	0	0	0	8.4
6.	*Irvingia gabonensis*	Irvingiaceae	10	12	12	9	6	10	9	9	12	2	1	3	8.0
7.	*Capsicum frutescence*	Solanaceae	0	4	12	1	0	7	2	12	4	18	0	0	5.1
8.	*Helianthus annus*	Asteraceae	0	5	24	29	0	1	0	1	0	0	0	0	5.1
9.	*Ixora parviflora*	Rubiaceae	0	0	1	0	0	0	0	1	0	8	0	0	0.8
10.	*Zea mays*	Poaceae	0	0	15	26	42	0	0	0	0	0	0	0	7.0
11.	*Mangifera indica*	Anacardiaceae	0	6	10	12	0	0	1	0	0	0	0	0	2.4
12.	*Elaeis guineensis*	Arecaceae	0	21	4	0	7	0	3	2	1	0	0	0	3.2
13.	*Tridax procumbens*	Asteraceae	0	0	0	6	5	4	1	16	0	0	0	3	3.0
14.	*Fabaceae*	Fabaceae	0	1	7	0	4	8	28	36	2	0	3	4	8.0
15.	*Treculia africana*	Moraceae	0	0	2	0	0	0	3	8	7	12	7	0	3.3
16.	*Acacia sp.*	Fabaceae	0	1	2	2	1	0	1	1	0	0	0	0	0.6
17.	*Talinum triangulare*	Portulacaceae	0	0	0	1	0	0	1	0	2	1	0	0	0.4
18.	*Aulacosiera sp.*	Aulacoseiraceae	0	0	1	0	21	1	14	10	15	4	3	1	6.0
19.	*Alchornea cordifolia*	Euphorbiaceae	0	0	1	15	5	0	2	3	1	1	0	0	2.3
20.	*Terminalia catappa*	Combretaceae	0	0	0	0	0	0	0	1	1	1	0	1	0.3
21.	*Nigrospora sp.*	Trichosphaeriaceae	8	0	0	0	0	0	0	0	0	0	0	2	0.8
22.	*Torula sp.*	Torulaceae	0	0	0	21	19	15	11	0	0	0	2	0	6.0
23.	*Alternaria sp.*	Pleosporaceae	0	0	0	14	0	0	2	0	0	0	0	0	1.3
25.	*Curvularia sp.*	Pleosporaceae	0	0	0	0	0	0	10	0	4	15	4	1	3.0
26.	*Helmithosporium*	Massarinaceae	0	6	11	9	1	0	0	0	0	0	0	0	2.2
27.	*Pithomyces sp.*	Pleosporaceae	0	0	0	0	9	22	11	0	1	3	4	0	4.2
28.	*Pollen indeterminate*	Pollen Indeterminate	0	2	0	3	0	0	10	0	0	0	1	0	1.3

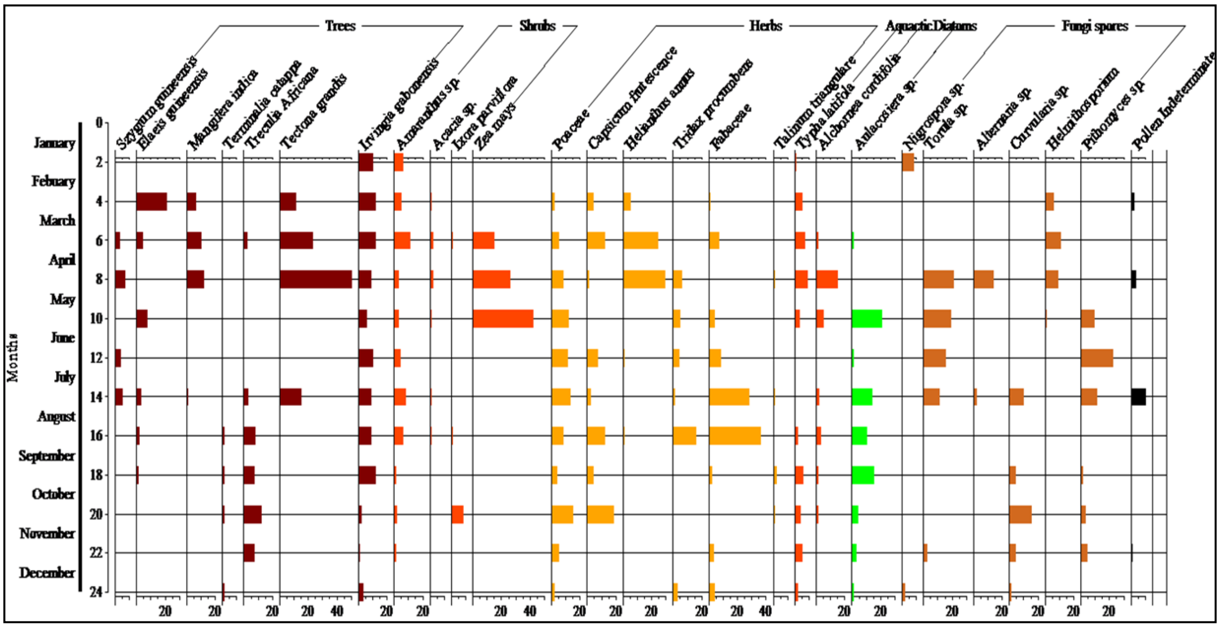


Fig 2: Pollen spectra from spider webs

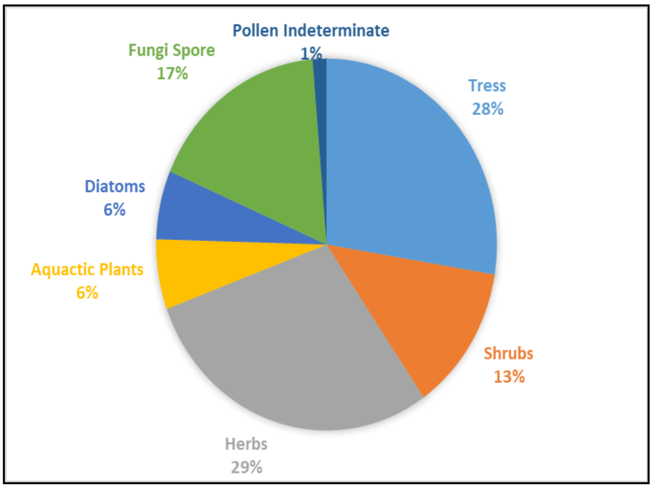
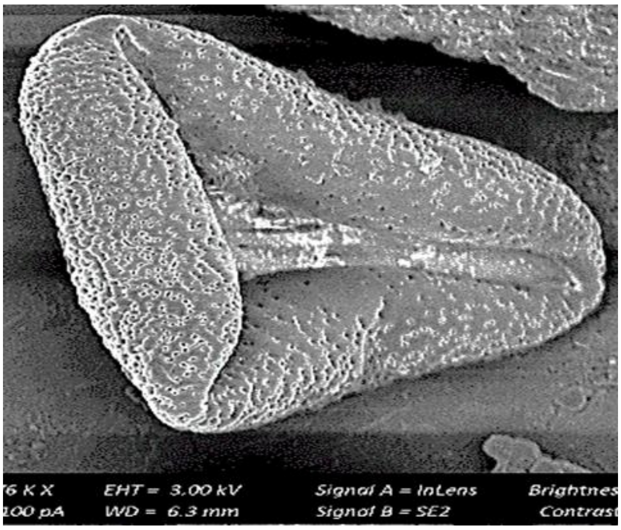
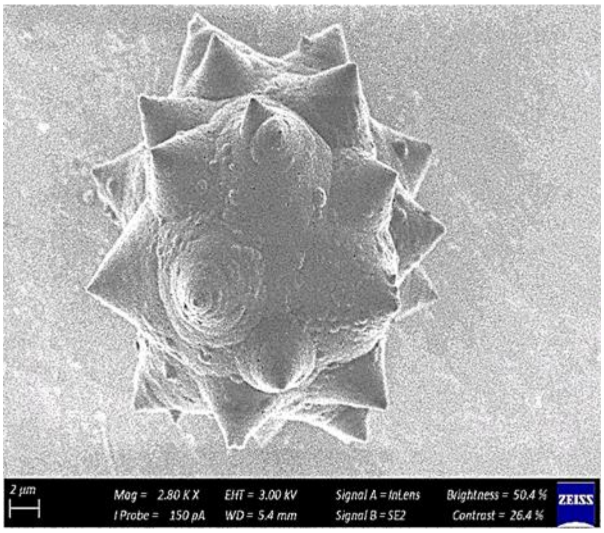


Fig 3: Pie diagram of the spider-web samples showing the major components of the pollen rain in Ijegun.

Thus, the analysis has shown that position, size, height, and age of the spider web have reflected in the pollen assemblage that is retained due absent of some ecological group (Figure 2). Among the arboreal pollen trapped in webs, are the predominating herb taxa and their representation corresponds largely with their presence in the local flora. The low recovery of palynomorphs of the extant plants being recorded despite their common constituents of the floristics and can be attributed to low pollen productivity, differential pollen preservation, wind speed, and humidity are other local factors that affect the retention of pollen grains and spores in webs. Likewise, the feeding habit of the spider requires radical revision. Thus, a spider would best be described as omnivores rather than carnivores that arachnologists have always assumed them to be. Spiders obtain substantial nutrition from the pollen and fungi from their webs, thereby reducing the concentration of the palynomorphs for aeropalynological studies.





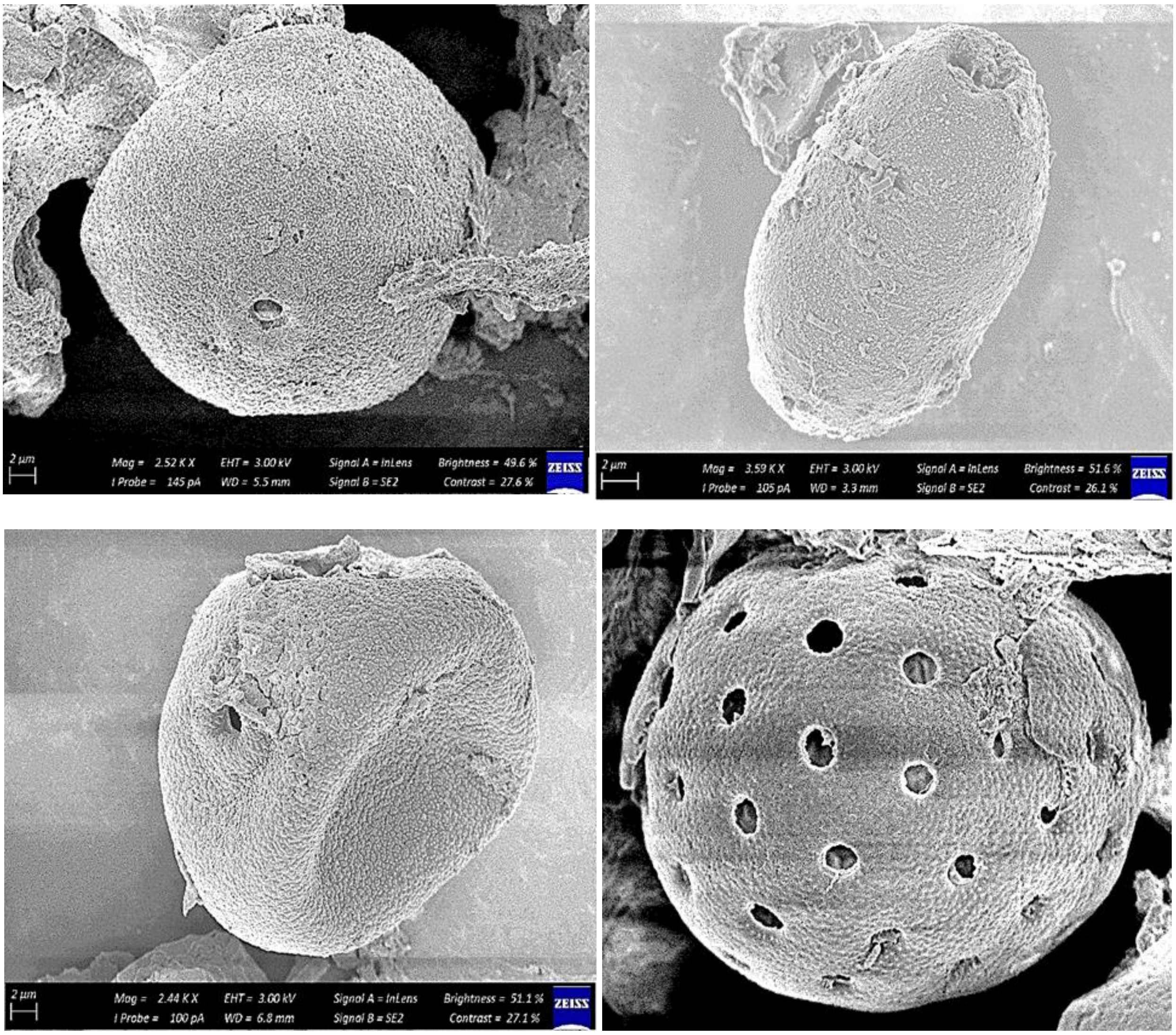


Plate 1: (a) *Elaeis guineensis* (b) *Helianthus annus* (c) Poaceae (d) *Torula* sp. (e) *Zea Mays* (f) *Amaranthus* sp.

During microscopy studies, we observed that only pollen (≥ 2) and fungi (≥ 3) of these ranges were discovered. These support the assertions made by [18] that fungi spores (3 ≥ 30um in diameter) and pollen grains (2 ≥ 5um in diameter)), are too large to pass through the cuticular platelets of the spider's pharynx [15]. Furthermore, the high recovery of anemophilous pollen when compared to the pollen of insect-pollinated plants suggest that the wind-pollinated plants is nutritionally poorer than the pollen from the insect-pollinated plants. There are distinct differences in nutritional value among species of pollen which is also a factor for using spider web for aeropalynological studies.

Poaceae was dominant during both season, but more prevalent during the wet season. These support the assertions made by [20], stating that most pollen grains found as allergens are wind-pollinated, characteristic of a light-weight and may be dispersed to considerable distances. Also, *Zea mays* which is also a member of the Poaceae group recorded an up thrust increase during the first quarter of the wet season (March to May) [23]. Is of the view that airborne Poaceae pollen consists of allergens capable of releasing microscopic particles into the atmosphere after dehiscence. The incidence of atmospheric Poaceae pollen is globally most important as a trigger of allergic reactions and has been implicated in Pollinosis, as stated by [24]. *Tectona grandis, Irvingia gabonensis, Capsicum frutescence, Helianthus annus*, *Zea mays,* Fabaceae, *Aulacosiera* sp., and *Torula* sp. were dominant throughout the seasons and can be said to be allergic due to their prolific nature in terms of production and size. The dominance of fungal spores during the wet season is an indication of humid nature. Rate of occurrence and severity of allergenic reactions in urban population have been recorded to be higher than the rural population, which could be as a result of anthropogenic activities in cities carried by the pollen grains and fungal spores, thus enhancing the allergenic potentiality. The spores of *Torula* and the allergenic pollen are known to be prevalent sources of allergens in the atmosphere. This allergen tends to cause respiratory problems like asthma and allergic rhinitis or seasonal allergy (hay fever). Further research looking into the causes behind this is required. However, the study could also entail the evaluation of the allergenicity of different pollen grains and spores in the area of investigation, causing asthma, hay fever, dermatitis, and other disorders. Allergic diseases can be controlled and symptoms can be minimized if we know what triggers them. Thus, the study may be useful for allergologists in establishing the right diagnosis which will ultimately enable an improved quality of life for the inhabitants of the area of investigation. The results of the study may be used in public awareness programs about the health hazards caused by pollen grains.

4. Conclusion

This study has shown that, Humans who are allergic to pollen grains and spores in these study locations are exposed to considerably similar types of atmospheric pollen grains and spores, consequent of which they may experience some allergic conditions during the month of October to March, which includes seasonal rhinitis, itchy skin, asthma, hay fever, and conjunctivitis among others in these locations. It will help pollen allergy sufferers to identify plants producing allergenic pollen in their communities and adopt proactive measures against this threat.

5. Acknowledgments

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