Annals of West University of Timişoara, ser. Biology, 2025, vol. 28 (2), pp.167-192

SEASONAL VARIATION OF AIRBORNE POLLEN AND SPORE CONCENTRATION IN THE UNIVERSITY OF LAGOS, AKOKA, LAGOS, NIGERIA

Temitope O. ONUMINYA[1,2]*, Okwong J. WALTER[1,2], Linus B. AJIKAH[3,2,4], Oluwatoyin T. OGUNDIPE[1,2], Toluwalope S. BOLARINDE[1]

[1]Department of Botany, Faculty of Science, University of Lagos, Akoka, Lagos, Nigeria
[2]TETFUND Center of Excellence in Biodiversity Conservation and Ecosystem Management
[3]Department of Plant and Ecological Studies (PES), Faculty of Biological Sciences, University of Calabar, Calabar, Cross River State, Nigeria
[4]Evolutionary Studies Institute (ESI), Faculty of Science, University of the Witwatersrand. Johannesburg, South Africa
**Corresponding author's e-mail: okwong56@gmail.com*
Received 6 October 2025; accepted 29 December 2025

ABSTRACT
Airborne pollen grains and spores are significant allergens that contribute to human allergic reactions. This study aimed to monitor allergenic airborne pollen in the city of Lagos and to strengthen and extend this network to other cities in the country. Weekly aeroallergen sampling was conducted from May 2023 to April 2024 using the Burkard 7-day recording volumetric spore trap, and samples were analyzed via direct mounting and standard microscopy. A plotless sampling method was used for extensive plant assessment across five designated areas. Palynological data were statistically analyzed and correlated with mean monthly values for rainfall, air temperature, wind speed, and relative humidity, obtained from the Nigeria Meteorological Agency (Abuja) using Pearson's correlation ($P < 0.05$). The study identified 104 plant species belonging to 100 genera and 42 families. A total of 5,812 palynomorphs belonging to 54 families were recovered. The dominant pollen grains and spores were those of Bombax buonopozense, Phyllanthus amarus, Alchornea cordifolia, Cyperus sp., Spigelia anthelma, Nigrospora sp., Glomus sp., and Nephrolepsis biserrata. Significant positive correlations were found between pollen counts and temperature/wind speed, whereas relative humidity and rainfall showed weak negative correlations. These correlations provide valuable insights into how weather conditions influence the distribution of pollen and spores in the atmosphere. This study provides a detailed pollen and spore calendar that helps identify local aeropalynology patterns and potential allergy seasons. This study is vital for healthcare professionals in managing allergy symptoms and provides a detailed comparison of local plant species with pollen records.
KEY WORDS: *Flora; Palynomorphs; Burkard; Allergy, Seasons; University of Lagos*

INTRODUCTION

Pollen concentration and diversity in any region are influenced by both the local and surrounding vegetation (Walter *et al.*, 2023). Atmospheric pollen levels vary over time, and are affected by meteorological, ecological, and geographical factors (Cristofolini *et al.*, 2024). Because of their differing sizes, pollen grains can cause various allergic reactions, with smaller grains being more likely to penetrate the respiratory tract and trigger symptoms (Akpınar & Altunoğlu, 2024). These allergic responses are primarily driven by proteins in the pollen and contribute to the increasing prevalence of respiratory conditions, such as asthma, rhinitis, allergic conjunctivitis, and atopic dermatitis, particularly in arid and semi-arid regions (Ajikah *et al.*, 2020; Zhang *et al.*, 2024; Ciobanu & Ianovici). Monitoring the types and concentrations of allergenic pollen is crucial for understanding the regional health risks (Ianovici *et al*, 2015). Allergic rhinitis and asthma are becoming more common in Nigeria, especially in Lagos, which has the highest prevalence among surveyed cities (Ozoh *et al.*, 2019). This underscores the urgent need for aerobiological research, particularly in densely populated urban centers such as Lagos, where various environmental factors, such as vegetation type, climate, topography, and demographics interact to influence allergy trends. Lagos, with its rich native and nonnative flora, hosts a wide array of common aeroallergens (Ajikah *et al.*, 2021). However, pollen and allergy monitoring in many parts of the city have been poorly studied. Climate change further exacerbates this issue, as data from the Northern Hemisphere indicates increased pollen production and earlier pollen seasons. These environmental changes, combined with the biodiversity of Lagos, highlight the importance of expanded aerobiological surveillance to protect public health. Despite its high-risk profile, lagoons remain underrepresented in global aerobiology networks. Over 879 pollen monitoring stations exist globally, with more than 500 in Europe, whereas Africa hosts only four active spore traps (Buters *et al.*, 2018). In Nigeria, reliance on outdated methods like the modified Tauber-like spore trap limits the consistency and accuracy of pollen data collection. To bridge this gap, there is an urgent need for real-time automated pollen monitoring systems in Lagos, especially in densely populated areas. Expanding research into less-studied parts of the city will improve understanding of allergy triggers and contribute to global efforts in evaluating the health impacts of climate change. Monitoring pollen seasons and identifying peak periods will enable allergy sufferers to take timely preventive actions. This study focused on tracking allergenic palynomorphs and examining how meteorological factors affect pollen concentrations, offering critical insights to help healthcare providers and policymakers manage allergy seasons more effectively.

MATERIALS AND METHODS

Study sites. The sampling site was located at the Erastus Akingbola Postgraduate Hall (Longitude: 3° 23' 52" E, Latitude: 6° 31' 3" N) at the University of Lagos, within the Yaba Local Government Area of Lagos. Mapping of the sampling points was done using Arc GIS 10.3.1 software (Figure 1). The environment consists of mangrove, coastal terrain, and wetlands. It is predominantly covered by mangrove swamps (50%) and brackish lagoon waters, which are minimally disturbed by human activities. The study area has a humid tropical climate with two wet seasons (April–July and October–November) and two dry seasons (August and December–March). The annual rainfall ranges from 1381.7 mm to 2733.4 mm, averaging 2500 mm, with monthly rainfall varying from 25 mm to over 400 mm. Temperatures ranged between 21 and 35°C (max) and 21–25°C (min), while relative humidity remained high, exceeding 75% year-round. Wind patterns follow the Intertropical Convergence Zone (ITCZ) shifts: Southwest monsoon winds dominate the wet season, while northeast trade winds bring dry conditions from October onward.

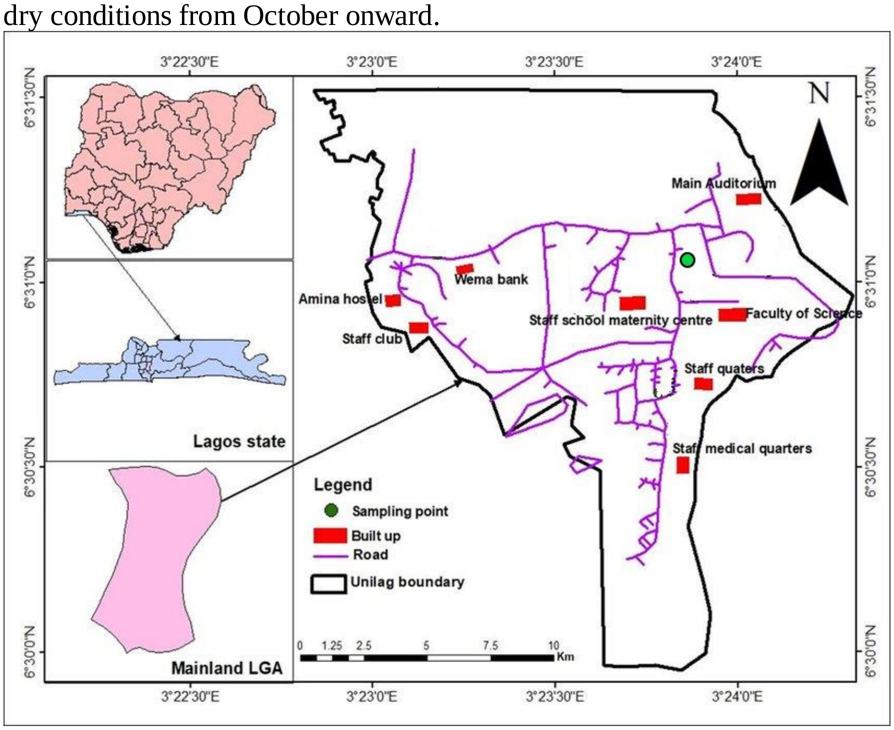

FIG 1. The study area

Sample Collection and Analysis. The study was conducted over a 12-month period, from May 2023 to April 2024, using the Burkard 7-day recording volumetric spore trap which was installed in April 2023 on the rooftop of the Erastus Akingbola Postgraduate Hall (15 m above ground level) at the University of the Lagos, a compact device with a built-in vacuum pump designed to continuously collect airborne particles such as pollen and fungal spores. This type of sampler, based on the Hirst-type volumetric spore trap originally designed by Dr. James Hirst in 1952 and widely used in aerobiological studies (Buters *et al.,* 2018; Ajikah *et al.*, 2020), for tracking seasonal and diurnal trends in aerospora. Sampling occurred daily at a designated site, with the Burkard trap operating at a constant air intake speed of 10 L/min and a drum rotation speed of 2 mm/hr. The trap features a suction slit impactor where air is drawn through a 14 × 2 mm orifice, allowing for the efficient collection of even the smallest spores. The device's rotating head aligns with prevailing wind direction using attached fins to maximize collection efficiency. The process began by preparing the trapping surface: a 345 mm strip of Melinex tape was wrapped around the rotating drum and aligned with black reference marks, ensuring that the join met the black mark labeled 'B'. A thin layer of Vaseline adhesive was applied using a flat brush to avoid blocking the orifice. Once the drum was properly aligned and secured with the brass locking nut, the drum and clock units were lowered into the trap, and the anti-swivel pin was positioned vertically. After seven days of exposure, The Melinex tape, coated with Vaseline jelly, was segmented into daily portions and mounted on 26 × 76 mm microscope slides with 24 × 50 mm coverslips using glycerol jelly. Microscopic examination was carried out using an Olympus CH-20i light microscope at the University of Lagos. Pollen grains were identified using morphological characteristics and compared with modern reference collections and published identification keys in the Palaeobotany and Palynology laboratory.

Vegetation Study. The survey was conducted between April and June 2024. A plotless sampling method was employed for extensive plant assessments across the five designated areas. All living trees (GBH at 1.3 m) greater than or equal to the midpoint were measured using girth tape. Tree heights were measured using the Haga Altimeter within a fixed distance from the tree using the trigonometric principle and slope as a percentage. Sub-quadrats of 1m x 1 m were established. These plots were laid out and sampled for herbaceous species and grass. Taxa identification and classification were performed on-site using the morphological description of flora, manuals, and monographs (Akobundu & Agyakwa, 1998), and a comparison of the plant specimen samples with the preserved dried samples at the University of Lagos Herbarium (Department of Botany), Nigeria. Species nomenclature and authorities were validated using the International Plant Name Index database (International Plant Name Index database (IPNI), 2024).

Vegetation Diversity. Vegetation data obtained from the study were subjected to a comparative floristic assessment utilizing descriptive statistics and biodiversity indices, in accordance with the methodology of O Omomoh *et al.* (2019). These analyses were executed using PAST software (version 4.13c; Hammer *et al.*, 2001), with a significance level set at $p \leq 0.05$. In characterizing the structural composition of the forest, plant species were classified into five life forms climbers, herbs, grasses, shrubs, and trees based on the tropical classification framework established by Mueller-Dombois (1972). Furthermore, the conservation status of each recorded species was assessed using the IUCN Red List of Threatened Species (2022). The classifications included: Not Evaluated (NE), Data Deficient (DD), Least Concern (LC), Near Threatened (NT), Vulnerable (VU), Endangered (EN), Critically Endangered (CR), Extinct in the Wild (EW), and Extinct (EX).

Vegetational Analysis

Basal Area (BA). The basal area of all trees was calculated using this formula:

$$BA = \frac{\pi D^2}{4} \quad (1)$$

where, BA = Basal area (m2), D = Diameter at breast height (cm) and л = pie (3.142). The total BA for each plot was obtained by adding all trees BA in the plot (Ogunyebi *et al.*, 2018).

Relative Density (RD). Which is an index for assessing species relative distribution and was computed with:

$$RD = \frac{n_i}{N} \, x\, 100 \quad (2)$$

where RD (%) is species relative density; n_i is the number of individuals of species i; and N is the total number of all individual trees of all species in the entire community (Walter *et al.*, 2025).

Relative Dominance (RD*o*) was estimated using: $RD_o = \frac{\sum Ba_i \, x\, 100}{\sum Ba_n}$ (3)

where Bai is basal area of all trees belonging to a particular species i and Ban is basal area of all trees in a plot (Walter *et al.*, 2025).

Family Importance Value. This was used to estimate a family's share in the forest community (Walter *et al.*, 2025):

$$FVI = \frac{(\text{RD} + \text{RDo})}{2} \quad (4)$$

Importance Value Index (IVI). This was used to express the share of each species in the tree community (Walter *et al.*, 2025):

$$IVI = \frac{(\text{RD}\ x\ \text{RDo})}{2} \quad (5)$$

Procurement of Meteorological Data. Meteorological data, including air temperature, wind speed, relative humidity, and rainfall, were collected from the Nigerian Meteorological Agency (NIMET) in Abuja for the duration of the study period. These parameters are critical for understanding the seasonal variations in atmospheric pollen load, as they directly influence the distribution and dispersal of pollen.

Statistical Analysis and Data Presentation. Pearson correlation test ($p < 0.05$) was conducted to assess the strength and statistical significance of the relationship between the total monthly pollen count and various meteorological parameters, such as temperature, humidity, and wind speed.

Development of Pollen Calendar. The percentage calculations for each pollen type were based on the total pollen sum used to construct the pollen diagram, as outlined by Adekanmbi *et al.* (2021). The pollen diagram itself was created using the Tilia 2.0.41 and TGView software (Grimm, 2013), which are specialized tools for visualizing palynological data. These diagrams provide a comprehensive seasonal overview of airborne pollen and spore data. The pollen calendar is organized by month, displaying the various pollen and spore species identified within the study area. Additionally, the mean abundance of each pollen and spore type is calculated and presented in relation to each month of the year, offering insights into the seasonal periodicity and ecological dynamics of the region under investigation. This approach allows for a clear visualization of how different plant species contribute to the airborne pollen load throughout the year.

RESULTS AND DISCUSSIONS

Pollen and Spore Analysis. The data presented in Tables 1 and 2 elucidate the monthly distribution of pollen and spores across diverse plant taxa and families from

May 2023 to April 2024. 5,208 pollen grains were counted, representing 63 distinct pollen types from 30 families. Furthermore, 667 spores were documented, encompassing 13 spore types from 13 families. The highest total number of pollen concentration reaches its maximum peak in January 2024, with 625 pollen counts, followed closely by February 2024 with 604 pollen counts. These months exhibit a significant increase in pollen counts compared to other months (Table 1). The months of August and May 2023 demonstrate the lowest counts, with only 131 and 387 pollen respectively. The family-level trends indicate that the Acanthaceae family exhibits a consistent presence throughout the study period, particularly increasing in July 2023 (34) and January 2024 (13). However, *Nelsonia canescens* (Acanthaceae) displays a distinct peak in October 2023 (40), followed by a decrease to zero occurrences in the subsequent months (Figure 4a). Multiple genera from the Anacardiaceae family demonstrate significant fluctuations, with *Anacardium occidentale* and *Mangifera indica* exhibiting peaks in October 2023 (Figure 4b). The genus *Spondias mombin* also displays several spikes in different months, significantly in May 2023 (25) and in April 2024 (19). The *Elaeis guineensis* and *Cocos nucifera* genera demonstrate substantial occurrences throughout the study period, with *Elaeis guineensis* reaching its maximum in July 2023 (26). Both genera exhibit a steady presence, contributing significantly to the overall taxa counts each month. The Fabaceae family is well-represented by various genera, such as *Albizzia, Senna*, and *Delonix*, with *Senna siamea* reaching a peak of 28 occurrences in July 2023. *Senna alata*, another significant species from this family, also exhibits fluctuations, particularly in the months leading into the second half of the study period, peaking in April 2024. Significant trends in specific pollen taxa indicate that *Carica papaya* from the Caricaceae family demonstrates a significant presence, particularly in June (33) and July 2023 (38). This may indicate a seasonal flowering pattern. *Terminalia catappa* in the Combretaceae family is consistent, with occurrences in June 2023 (19) and a peak in March 2024 (37). *Tridax procumbens* (a member of the Asteraceae family), which reached its maximum peak in September (40), appears to be a highly variable pollen across the months. Similarly, *Emilia praetermissa* peaks in June 2023 (8) and March 2024 (10) as shown in Figures 4a and 4b.

TABLE 1. Atmospheric pollen count of University of Lagos Akoka Campus

		May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	%
Plant taxa	**Family**	**2023**								**2024**				
Nelsonia canescens (Lam.) Spreng.	Acanthaceae	0	0	0	0	0	40	14	7	23	0	0	0	1.6380
Asystasia gangetica (L.) T. Anderson	Acanthaceae	0	0	0	0	0	0	15	34	4	13	11	8	1.6575
Anacardium occidentale L.	Anacardiaceae	3	10	6	0	0	65	29	15	1	0	0	0	2.5156
Mangifera indica L.	Anacardiaceae	5	29	2	0	0	0	13	34	16	17	7	4	2.4765
Spondias mombin L.	Anacardiaceae	25	14	0	0	0	0	0	0	0	0	0	19	1.1310
Spondias tuberosa Arruda	Anacardiaceae	16	27	18	0	0	0	0	0	14	9	15	0	1.9305

Polyalthia longifolia (Sonn.) Thwaites	Annonaceae	33	1	21	0	0	0	0	0	0	0	32	14	1.9695
Holarrhena floribunda (G. Don) Dur. & Schinz	Apocynaceae	33	1	28	0	0	0	0	0	0	0	0	21	1.6185
Rauvolfia vomitora Afzel.	Apocynaceae	11	11	10	0	0	0	0	21	24	1	0	0	1.5210
Thevetia nerifolia Juss.	Apocynaceae	0	0	0	0	7	4	17	8	3	46	2	2	1.7355
Cyrtosperma senegalense (Schott) Engl.	Araceae	5	10	28	0	0	0	0	0	0	0	0	0	0.8385
Cocos nucifera L.	Arecaceae	8	5	22	0	0	0	0	0	6	4	5	1	0.9945
Elaeis guineensis Jacq.	Arecaceae	3	17	26	5	19	0	6	2	4	3	3	1	1.7355
Tridax procumbens L.	Asteraceae	0	0	2	18	40	16	16	16	3	34	21	18	3.5881
Emilia praetermissa Milne-Redh.	Asteraceae	0	8	3	9	1	0	0	0	4	10	3	3	0.7995
Bombax buonopozense P. Beauv.	Bombacaceae	0	0	0	0	0	0	53	16	40	41	16	2	3.2761
Ceiba pentandra (L.) Gaertn.	Bombacaceae	0	0	0	0	0	0	33	12	19	30	6	0	1.9500
Carica papaya L.	Caricaceae	3	33	38	0	0	0	0	13	11	0	0	0	1.9110
Casuarina equisetifolia L.	Casuarinaceae	0	3	23	0	0	0	0	0	0	0	0	0	0.5070
Chrysophyllum albidum G. Don	Chrysophylloideae	0	0	0	0	0	0	0	0	33	38	8	0	1.5405
Terminalia catappa L.	Combretaceae	11	19	18	0	0	0	0	0	0	0	37	36	2.3595
Terminalia mantaly H. Perrier	Combretaceae	1	17	16	0	0	0	0	0	0	0	43	18	1.8525
Ipomea batata (L.) Lam	Convovulaceae	24	12	0	0	0	0	0	0	8	5	6	0	1.0725
Hewittia sublobata (L.f.) Kuntze	Convovulaceae	2	2	3	0	0	0	0	0	0	0	0	7	0.2730
Ipomea cairica (L.) Sweet	Convovulaceae	0	0	0	11	24	12	11	17	0	0	0	0	1.4625
Cyperus sp.	Cyperceae	20	7	5	0	0	0	0	0	44	36	14	32	3.0811
Bridelia micrantha (Hochst.) Baill.	Euphorbiaceae	0	1	6	0	0	0	1	67	20	16	9	0	2.3400
Hura crepitans L.	Euphorbiaceae	0	12	4	0	0	0	0	0	46	22	12	13	2.1255
Alchornea cordifolia (Schum. & Thonn.) Müll. Arg.	Euphorbiaceae	14	21	6	0	0	0	0	7	35	43	39	19	3.5881
Phyllanthus amarus Schum. & Thonn.	Euphorbiaceae	23	19	13	35	12	1	0	0	0	0	0	0	2.0085
Spondias mombin L.	Fabaceae	5	11	17	0	0	0	0	0	0	0	4	48	1.6575
Albizia sp.	Fabaceae	5	0	7	0	12	20	3	0	0	0	0	57	2.0280
Albizia zygia (DC.) J. F. Macbr.	Fabaceae	0	5	7	0	0	0	0	0	0	31	15	11	1.3455
Bauhinia monandra Kurz.	Fabaceae	0	0	4	0	0	0	7	12	5	4	10	2	0.8580
Senna siamea (Lam.) H.S. Irwin & Barneby	Fabaceae	12	27	25	0	0	0	0	0	5	6	9	9	1.8135
Delonix regia (Gul Mohr) Raf.	Fabaceae	7	10	0	0	0	0	0	0	0	0	0	6	0.4485
Dialium guineense Willd.	Fabaceae	0	9	1	0	0	20	20	1	5	0	0	0	1.0920
Erythrina senegalensis DC.	Fabaceae	6	0	0	0	0	24	11	0	0	9	19	5	1.4430
Gliricidia sepium (Jacq.) Walp.	Fabaceae	1	0	0	0	0	0	0	0	0	10	25	19	1.0725
Senna alata (L.) Roxb.	Fabaceae	0	28	3	0	0	0	0	0	0	0	19	19	1.3455
Senna fistula L.	Fabaceae	7	0	0	0	0	0	0	0	0	0	3	7	0.3315
Millettia thonningii (Schum. & Thonn.) Bak.	Fabaceae	0	0	0	0	0	1	8	20	15	3	1	1	0.9555
Senna occidentalis occidentalis (L.) Link	Fabaceae	11	5	0	0	0	0	0	0	2	2	0	0	0.3900
Lonchocarpus sericeus (Poir.) Kunth ex DC	Fabaceae	8	17	32	11	1	0	0	0	8	0	0	0	1.5015
Spigelia anthelmia L.	Loganiaceae	0	0	0	0	0	0	23	22	47	20	4	0	2.2620
Anthocleista vogelii Planch.	Loganiaceae	2	0	0	0	0	0	0	0	0	7	23	12	0.8580
Lagerstroemia speciosa (L.) Pers.	Lythraceae	2	6	0	0	0	0	6	0	0	0	8	1	0.4485
Hildegardia barteri Mast. Kosterm.	Malvaceae	4	0	0	0	0	0	8	18	17	1	0	0	0.9360
Azadirachta indica A. Juss.	Meliaceae	0	2	3	0	0	0	0	20	12	11	5	0	1.0335
Mimosa pudica L.	Mimosaceae	4	0	0	0	0	0	0	0	18	12	16	25	1.4625
Ficus vallis-chaudae A. Juss.	Moraceae	2	9	9	0	0	0	0	0	0	0	0	5	0.4875
Ficus exasperata Vahl	Moraceae	0	0	10	0	0	0	0	0	0	10	0	5	2.2425
Milicia excelsa (Welw.) C. Berg	Moraceae	0	0	0	0	0	0	0	46	5	2	3	1	1.1115
Psidium guajava L.	Myrtaceae	17	12	27	0	0	0	0	0	3	11	3	10	1.6185
Phyllanthus muellerianus (Kuntze) Exell	Phyllanthaceae	0	8	18	0	0	0	0	0	8	27	12	11	1.6380
Zea mays L.	Poaceae	0	0	3	0	0	0	0	0	0	0	41	41	1.6575
Poaceae	Poaceae	10	1	11	27	22	12	21	55	62	29	10	15	5.3627
Charred poaceae cuticle	Poaceae	0	18	1	0	0	0	0	0	20	2	6	14	1.1895

Leptocholoa chinensis L. (Nees)	Poaceae	0	0	21	15	11	15	3	0	1	0	0	9	1.4625
Morinda lucida Benth.	Rubiaceae	12	4	0	0	0	0	0	0	0	35	13	14	1.5210
Citrus sinensis (L.) Osbeck	Rutaceae	10	4	0	0	0	0	0	0	6	1	0	0	0.4095
Blighia sapida K.D. Koenig	Sapindaceae	10	8	1	0	0	0	0	0	0	0	0	0	0.3705
Chrysophyllum albidum G. Don.	Sapotaceae	0	0	0	0	0	0	0	26	28	13	10	2	1.5405
Cola gigantea A. Chev.	Sterculiaceae	12	4	0	0	0	0	0	0	0	0	3	12	0.6045

TABLE 2. Atmospheric spore count of University of Lagos Akoka Campus

		May	**June**	**July**	**August**	**Sept.**	**Oct.**	**Nov.**	**Dec.**	**Jan.**	**Feb.**	**Mar.**	**April**	**%**
Plant taxa	**Family**	**2023**								**2024**				
Nigrospora sp.	Apiosporaceae	4	1	4	0	21	10	17	0	6	3	2	0	2.5269
Diatom frustule wall	Diatom	12	2	0	0	0	0	0	0	5	0	0	1	0.7432
Spegazzinia tesarthra	Didymosphariaceae	2	2	4	0	0	0	0	0	0	3	6	4	0.7803
Glomus sp.	Glomeraceae	21	34	10	30	60	15	15	0	2	3	1	0	7.0977
Insects Parts	Insects	0	6	1	0	0	2	14	0	12	16	3	5	2.1924
Nephrolepis biserrata	Nephrolepidaceae	0	0	0	0	21	1	0	0	0	0	3	2	1.0033
Plant fragments	Plants	0	4	3	5	0	1	12	14	29	15	7	2	3.4188
Helminthosporium maydis	Pleomassariaceae	8	1	6	0	0	0	0	0	0	0	0	6	0.7803
Curvularia sp.	Pleosporaceae	3	2	3	0	0	0	0	2	1	2	3	0	0.5945
Alternaria sp.	Pleosporaceae	0	0	6	0	0	18	0	0	1	2	0	0	1.0033
Stemphylium sp.	Pleosporaceae	0	0	2	0	12	14	0	0	0	2	5	1	1.3377
Pithomyces sp.	Pleosporaceae	3	1	0	0	0	0	0	0	0	3	2	3	0.4459
Pteris sp.	Pteridaceae	0	1	5	0	6	0	0	1	0	0	2	2	0.6317
Cookeina sp.	Sarcoscyphaceae	0	2	5	0	0	0	0	0	1	3	2	1	0.5202
Sordaria sp.	Sordariaceae	6	0	1	0	0	0	0	0	0	0	0	5	0.4459
Torula sp.	Torulaceae	2	18	0	0	0	0	0	0	3	0	2	3	1.0405
Zooplankton	Zooplankton	1	0	1	0	0	0	0	2	1	1	0	0	0.2229

TABLE 3. Structural analysis of trees species at the University of Lagos Akoka Campus

No.	**NAME**	**FAMILY**	**Freq**	**DBH (cm)**	**H (m)**	**mH**	**Ba^m2**	**RD (%)**	**RD0 (%)**	**IVI**	**FIV**	**Simpson index (D)**
1.	*Mangifera indica* L.	Anacardiaceae	22	26.3	597	27.1	0.054	0.191	0.007	0.001	0.099	4.31276
2.	*Greenway odendron* (Engl. & Diels) Verde	Annonaceae	31	717.3	546	16.0	40.410	0.269	4.918	0.661	2.593	8.56315
3.	*Cocos nucifera* L.	Arecaceae	11	197.9	183	16.0	3.076	0.095	0.374	0.018	0.235	1.07819
4.	*Elaeis guineensis* Jacq.	Arecaceae	3	51.5	64	21.3	0.208	0.026	0.025	0.000	0.026	8.01960
5.	*Newbouldia laevis* (P. Beauv.) Seem. ex Bureau	Bignoniaceae	1	68.1	33	33.0	0.364	0.009	0.044	0.000	0.026	8.91067
6.	*Tabebuia rosea* (Bertol.) DC	Bignoniaceae	17	716.5	437	25.7	40.320	0.147	4.907	0.362	2.527	2.57518
7.	*Carica papaya* L.	Caricaceae	2	47	25	12.5	0.173	0.017	0.021	0.000	0.019	3.56427
8.	*Casuarina equisetfolia* L.	Casuarinaceae	5	127	108	16.0	1.267	0.043	0.154	0.003	0.099	2.22767
9.	*Casuarina* sp. L.	Casuarinaceae	1	87.8	45	45.0	0.605	0.009	0.074	0.000	0.041	8.91067
10.	*Terminalia catappa* L.	Combretaceae	29	2046.7	813	28.0	329.00	0.251	40.039	5.032	20.145	7.49387
11.	*Terminalia mantaly* H. Perrier	Combretaceae	36	1228.2	711	19.8	118.47	0.312	14.418	2.249	7.365	1.15482
12.	*Terminalia superba* Engl et Diels	Combretaceae	13	41.1	333	25.6	0.133	0.113	0.016	0.001	0.064	1.50590
13.	*Hura crepitans* L.	Euphorbiaceae	2	52.4	63	31.5	0.216	0.017	0.026	0.000	0.022	3.56427
14.	*Albizia adianthifolia* (Schumach.) W. Wight	Fabaceae	3	316.2	94	31.3	7.853	0.026	0.956	0.012	0.491	8.01960
15.	*Albizia ferruginea* (Guill. et Perr.) Benth.	Fabaceae	2	136.7	57	28.5	1.468	0.017	0.179	0.002	0.098	3.56427
16.	*Albizia lebbeck* (L.) Benth.	Fabaceae	29	1523.3	853	29.4	182.24	0.251	22.179	2.787	11.215	7.49387
17.	*Albizia zygia* (DC.) J.F. Macbr.	Fabaceae	6	189.8	132	22.0	2.829	0.052	0.344	0.009	0.198	3.20784
18.	*Delonix regia* (Gul Mohr)	Fabaceae	28	83	630	22.5	0.541	0.243	0.066	0.008	0.154	6.98597
19.	*Dialium guineense* Willd.	Fabaceae	1	94.5	20	20.0	0.701	0.009	0.085	0.000	0.047	8.91067

20.	*Lonchocarpus sericeus* (Poir.) H. B. & K.	Fabaceae	1	64.4	24	24.0	0.326	0.009	0.040	0.000	0.024	8.91067
21.	*Milletia thonningii* (Schum. & Thonn.) Bak.	Fabaceae	11	569.7	233	21.2	25.491	0.095	3.102	0.148	1.599	1.07819
22.	*Senna fistula* L.	Fabaceae	11	377.5	205	18.6	11.192	0.095	1.362	0.065	0.729	1.07819
23.	*Irvingia gabonensis* Bailli.	Irvingiaceae	1	71	28	28.0	0.396	0.009	0.048	0.000	0.028	8.91067
24.	*Gmelina arborea* Roxb.	Lamiaceae	2	35.2	45	22.5	0.097	0.017	0.012	0.000	0.015	3.56427
25.	*Tectona grandis* L. f.	Lamiaceae	2	120.2	58	29.0	1.135	0.017	0.138	0.001	0.078	3.56427
26.	*Largerstoemia speciosa* L. (Pers.)	Lythraceae	7	442.1	128	18.3	15.351	0.061	1.868	0.057	0.964	4.36623
27.	*Adansonia digitata* L.	Malvaceae	1	180.1	16	16.0	2.548	0.009	0.310	0.001	0.159	8.91067
28.	*Bombax buonopozense* P. Beauv.	Malvaceae	1	93.7	38	38.0	0.690	0.009	0.084	0.000	0.046	8.91067
29.	*Cola gigantea* A. Chev. var. gigantea	Malvaceae	9	247.7	316	35.1	4.819	0.078	0.586	0.023	0.332	7.21764
30.	*Khaya grandifoliola* C. DC.	Meliaceae	5	429.5	209	41.8	14.488	0.043	1.763	0.038	0.903	2.22767
31.	*Khaya ivorensis* A. Chev.	Meliaceae	4	326.3	175	43.8	8.362	0.035	1.018	0.018	0.526	1.42571
32.	*Ficus benghalensis* L.	Moraceae	5	128.3	87	17.4	1.293	0.043	0.157	0.003	0.100	2.22767
33.	*Ficus exasperata* Vahl.	Moraceae	3	63.5	75	25.0	0.317	0.026	0.039	0.001	0.032	8.01960
34.	*Milicia excelsa* Welw. C.C.Berg	Moraceae	1	89.3	50	50.0	0.626	0.009	0.076	0.000	0.042	8.91067
35.	*Eugenia malaccensis* L.	Myrtaceae	5	94.4	94	18.8	0.700	0.043	0.085	0.002	0.064	2.22767
36.	*Psidium guajava* L.	Myrtaceae	10	144.1	143	14.3	1.631	0.087	0.198	0.009	0.143	8.91067
37.	*Bridelia micrantha* (Hochst.) Baill.	Phyllanthaceae	7	127.4	158	22.6	1.275	0.061	0.155	0.005	0.108	4.36623
38.	*Morinda lucida* Benth	Rubiaceae	2	90	51	25.5	0.636	0.017	0.077	0.001	0.047	3.56427
39.	*Citrus sinesis* (L.)	Rutaceae	1	25	22	22.0	0.049	0.009	0.006	0.000	0.007	8.91067
40.	*Blighia sapida* K. D. Koenig	Sapindaceae	4	66.4	76	19.0	0.346	0.035	0.042	0.001	0.038	1.42571

*F: Frequency; DBH: Diameter at Breast Height; BaHa-1: Basal Area per Hectar; RD: Relative Density; RDo: Relative Dominance; IVI: Important Value Index; FIV: Family Importance Value Index

Floristic Composition and Species Diversity

A comprehensive vegetation survey identified 104 plant species across 100 genera and 42 plant families. The plant species were categorized into various growth forms. Trees represented the largest proportion, accounting for 38.46% of the species (40 species). Frequently observed tree species included *Albizia lebbeck* (L.) Benth., *Greenway odendron* (Engl. & Diels) Verdc., *Terminalia mantaly* H. Perrier., *Cocos nucifera* L., *Millettia thonningii* (Schumach.) Baker., *Cola gigantea* A. Chev., *Bridelia micrantha* (Hochst.) Baill., *Albizia zygia* (DC.) J.F. Macbr., *Sida acuta* Burm.f., *Aystasia gigantica* (L.) T. Anderson, and *Khaya grandifoliola* C. DC (Figure 6). Among these, nine tree species were monotypic, belonging to a single species within their respective genera. Herbaceous species comprised 29.80% (31 species), with prominent species such as *Commelina erecta* L., *Tridax procumbens* L., *Oldenlandia corymbose* L., and *Vernonia cinerea* (L.). Less dominating the herbaceous plant records (Table 2). Grasses constituted 11.53% (12 species), with species such as *Imperata cylindrica* (L.) Raeusch., *Digitaria* sp., *Panicum maximum* Jacq., *Eleusine indica* (L.) Gaertn., and *Axonopus compressus* (Sw.) P. Beauv. among the most frequent. Shrubs comprised 10.57% of the species (11 species), while climbers and creepers accounted for 4.80% (5 species) as shown in figure 7. Most plant species were classified as Least Concern, indicating they are generally abundant and not at risk. Fewer species were listed as Data Deficient, Endangered, and Vulnerable, suggesting some conservation concerns due to limited data or threats to their survival (Figure 8).

This diversity indicates a wide range of plant forms, with certain species dominating their respective categories in terms of frequency of occurrence (Table 1). Families with the highest representation of individuals include Fabaceae (6 genera and 9 species), Combretaceae (1 genera and 3 species), Moraceae (3 genera and 3 species), and Malvaceae (3 genera and 3 species) as shown in figure 5. Species with the highest important value index (IV1) and family important value (FVI) include *Terminalia catappa* L. (5.0. 20.1), *Albizia lebbeck* (L.) Benth. (2.7, 11.2), *Terminalia mantaly* H. Perrier (2.2, 7.3), Greenway odendron (Engl. & Diels) Verde (0.6, 2.5), *Tabebuia rosea* (Bertol.) DC (0.3, 2.5), and *Milletia thonningii* (Schum. & Thonn.) Bak. (0.1, 1.5) respectively as shown in Table 1 and Figure 6. The highest Family Important Values (FIV) were recorded in Combretaceae (27.51), Fabaceae (14.55), and Annonaceae (2.59).

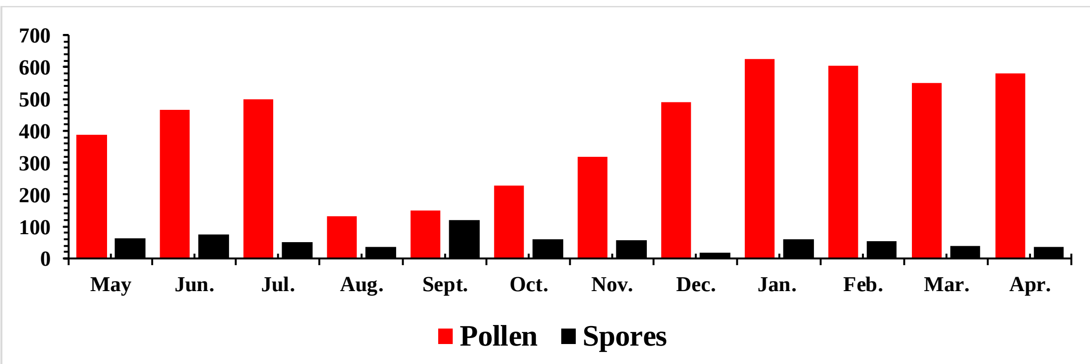

FIG 2. Monthly variations of atmospheric pollen and fungal spores from May 2023 to April 2024

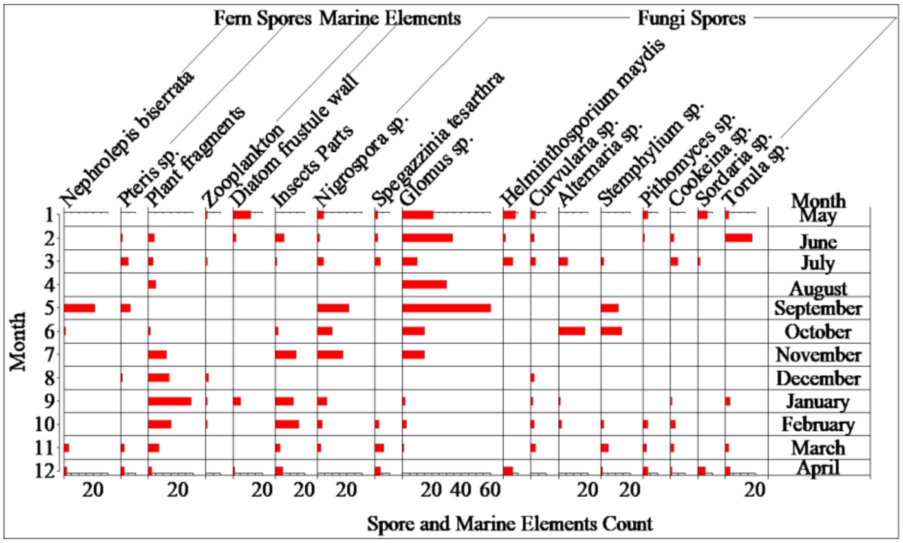

FIG 3. Monthly Percentage Distribution of Spore Taxa from May 2023 to April 2024

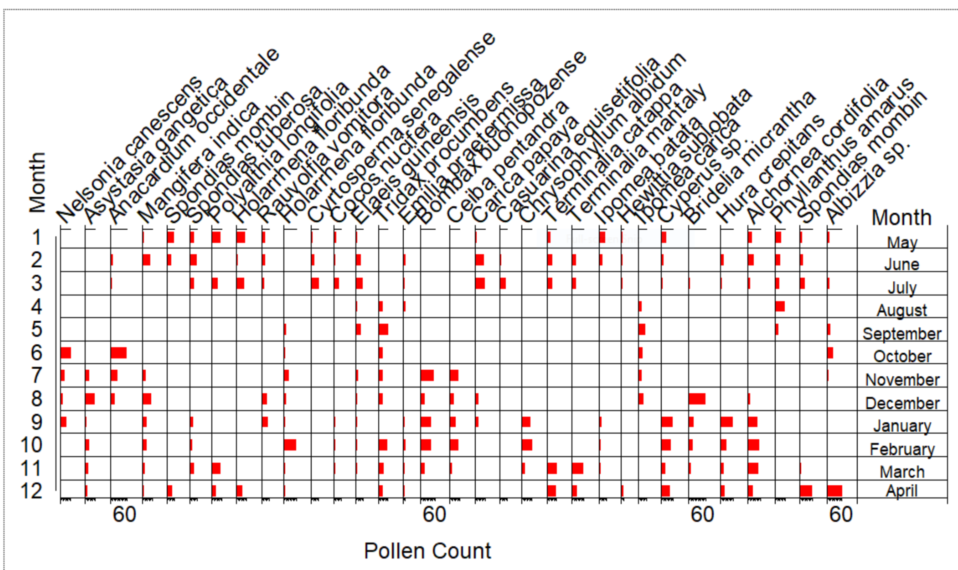

FIG 4a. Monthly Percentage Distribution of Pollen Taxa from May 2023 to April 2024

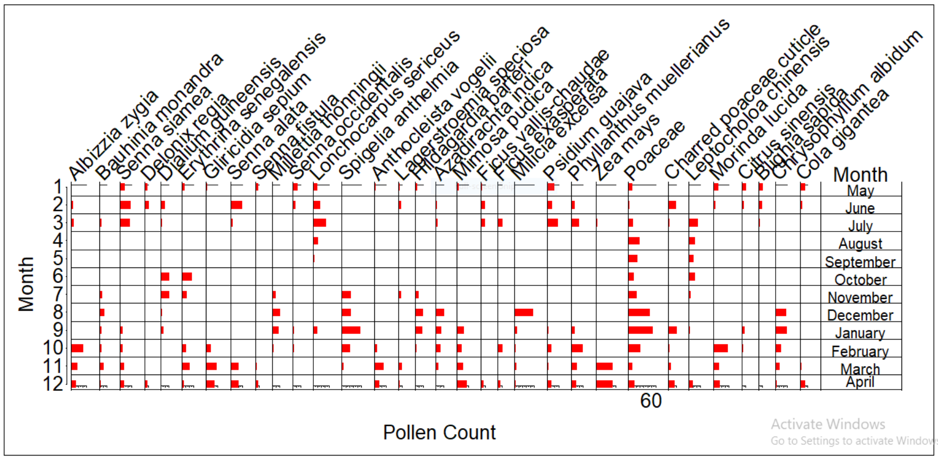

FIG 4b. Monthly Percentage Distribution of Pollen Taxa from May 2023 to April 2024

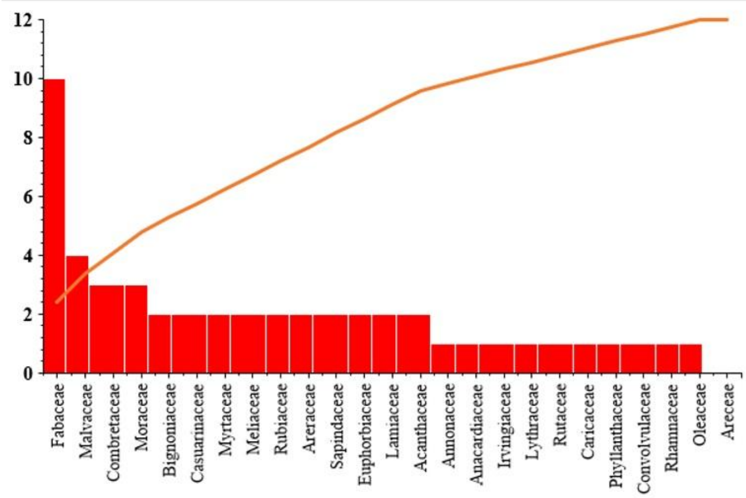

FIG 5. Number of Woody Species Per Family

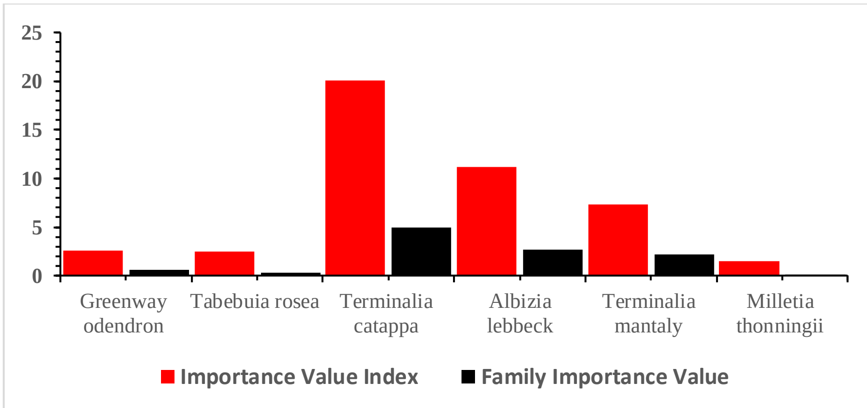

FIG 6. Woody Species with highest family important value index

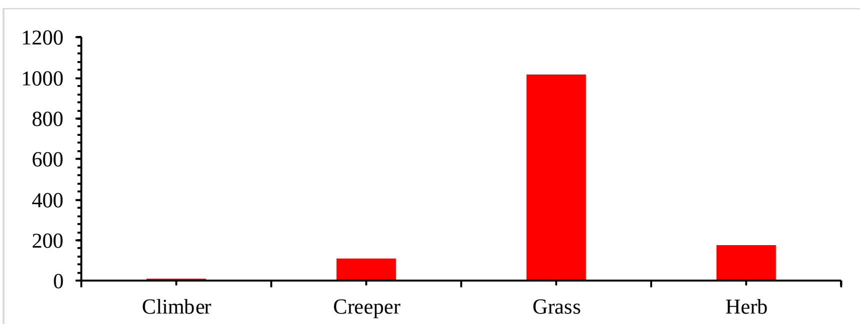

FIG 7. Sum of Frequency of Undergrowth by Habitat

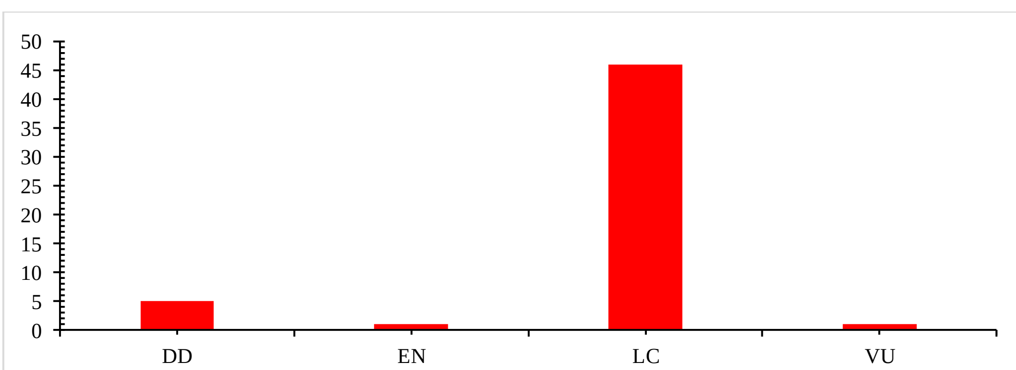

FIG 8. Number of Undergrowth Species by IUCN Status

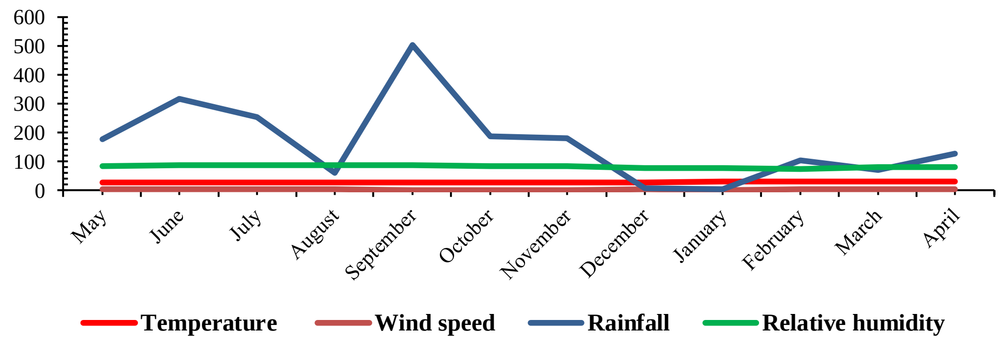

FIG 9. Mean monthly values of meteorological parameters in Lagos (May 2023–April 2024)

The plant diversity survey showed 335 tree/shrub individuals and 1,316 herb/grass individuals, illustrating the common trend of herbaceous plants outnumbering woody species. The Simpson's diversity index was higher for trees/shrubs (0.9418) compared to herbs/grasses (0.8988), indicating greater diversity in the woody community. Additionally, the Shannon's Entropy was higher for trees/shrubs (3.143) than for herbs/grasses (2.727), showing more balanced distribution among tree/shrub species. The Margalef Index indicated greater species richness in herbs and grasses (7.24) than trees and shrubs (6.708). Finally, the equitability index was also higher for trees and shrubs (0.8519) compared to herbs and grasses (0.6867).

Relationship between Atmospheric Pollen Types and Enumerated Local Plants. In the immediate vegetation of the study area at the University of Lagos, a diverse array of indigenous plant species was observed, contributing to the airborne pollen in the region. These species included *Tridax procumbens, Alchornea cordifolia, Casuarina equisetifolia, Elaeis guineensis, Bombax buonopozense, Sida acuta, Terminalia* sp., *Albizia* sp., and Poaceae (Tables 1 and 3). This diversity in pollen types provides a comprehensive representation of the local flora and its contribution to both local ecology and the surrounding environment.

Correlation between Monthly Total Pollen Counts and Meteorological Data. The study recorded monthly variations in rainfall, relative humidity, air temperature, and wind speed (Figure 9). A general increase in temperature was observed from October to April (dry season), with a decline during the wet months. Rainfall peaked in June and July, while relative humidity remained fairly stable (74–87%), likely due to proximity to water bodies or consistent atmospheric conditions (Figure 9). Wind speeds were significantly higher in August 2023 and February 2024, possibly due to seasonal weather patterns. Pollen counts showed moderate to strong positive correlations with air temperature and wind speed, but negative correlations with rainfall and humidity (Figure 10). In contrast, spore counts correlated positively with rainfall and humidity, and negatively with wind speed and temperature (Figure 10).

The spore analysis covers a range of recovered palynomorphs, including fungi, diatoms, plants, insects, and zooplankton, with a focus on their abundance within the study period (Table 2). *Glomus* sp. shows the highest abundance, particularly in May (21), June (34), and September (60). Diatom frustule wall though present throughout the year, had a significant peak in May (12) and January (5). *Spegazzinia tesarthra* and *Helminthosporium maydis* showed significant counts in multiple months, especially in May, June, and March (Table 2). *Nigrospora* sp. and *Glomus* sp., showed significant decrease in August and December (Figure 3). February and March showed an uptick in several taxa like *Spegazzinia tesarthra* and *Stemphylium* sp. The presence of insect parts fluctuates, with significant increases in August (14) and February (16). Zooplankton had relatively low but steady counts, with slight increases in May, November, and January (Figure 3).

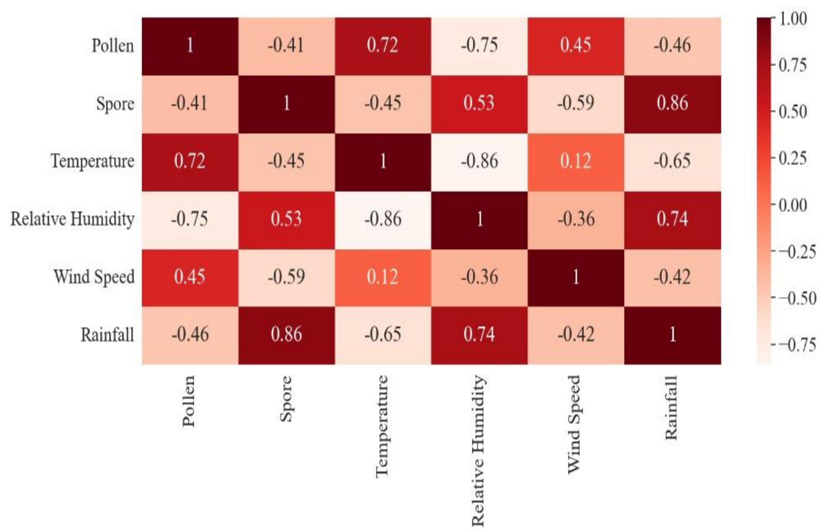

FIG 10. Correlation between total monthly palynomorphs count and meteorological parameters

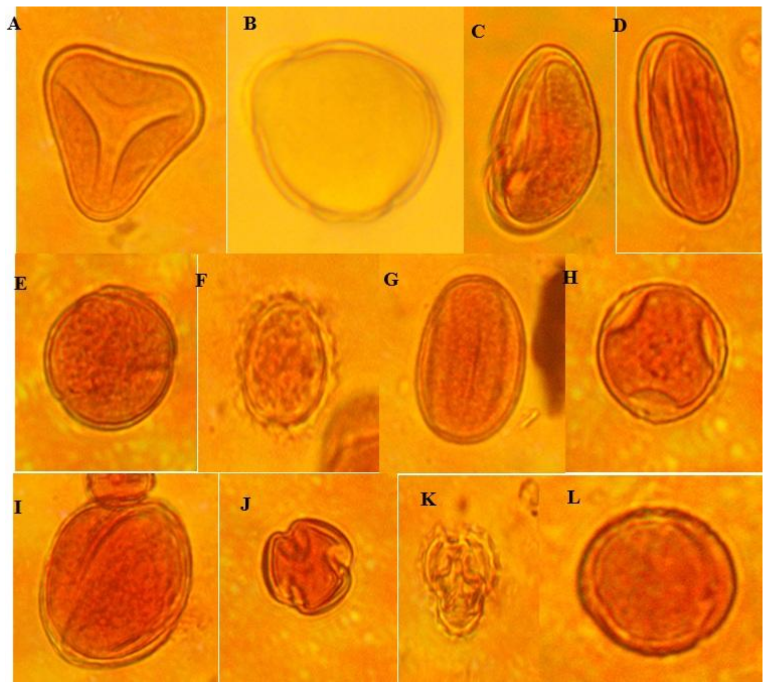

PLATE 1. Light photomicrographs of some palynomorphs recovered from the study area. (A) *Elaeis guineensis* (B) *Carica papaya* (C-D) Euphorbiaceae (E) *Senna siamea* (F) *Tridax procumbens* (G) *Berlinia grandiflora* (H) *Senna alata* (I) *Senna* sp. (J) *Ficus* sp. (K) *Emilia* sp. (L) *Canna indica* (× 400 Magnification, Scale bar 10 µm).

TABLE 4. Descriptive Statistics for the Undergrowth in the Study Area

No.	NAME OF SPECIES	FAMILY	HABITAT	FREQ.	RD	IUCN
1	*Ruellia tuberosa* L.	Acanthaceae	Herb	6	0.45	LC
2	*Trianthema* sp. L.	Aizoaceae	Grass	1	0.07	DD
3	*Alternanthera repens* Kunth	Amaranthaceae	Herb	1	0.07	LC
4	*Alternanthera sessilis* (L.) DC.	Amaranthaceae	Herb	2	0.15	LC
5	*Tridax procumbens L.*	Asteraceae	Herb	11	0.83	LC
6	*Vernonia cinerea* (L.) Lesss	Asteraceae	Herb	11	0.83	LC
7	*Eclipta alba* (L.) L.	Asteraceae	Herb	3	0.22	LC
8	*Synedrella nodiflora* (L.) Gaertn.	Asteraceae	Herb	3	0.22	LC
9	*Emilia praetermissa* Milne-Redhead.	Asteraceae	Herb	2	0.15	DD
10	*Aspilia africana* (Pers.) C.D. Adams	Asteraceae	Herb	3	0.22	LC
11	*Drymata cordata* (L.) Willd.	Caryophyllaceae	Herb	11	0.83	LC
12	*Commelina erecta* L.	Commelinaceae	Herb	33	2.50	LC
13	*Commelina diffusa* Burm.F	Commelinaceae	Herb	4	0.30	LC
14	*Ipomoea involucrate* P.Beauv.	Convolvulaceae	Climber	5	0.37	LC
15	*Merremia aegyptia* (L.) Urb.	Convolvulaceae	Climber	4	0.30	LC
16	*Merremia* sp. Dennst.	Convolvulaceae	Creeper	5	0.37	LC
17	*Ipomoea cairica* (L.) Sweet	Convolvulaceae	Herb	7	0.53	LC

18	*Hewitta malabarica* (LS.) Suresh	Convolvulaceae	Climber	1	0.07	LC
19	*Momodica charantia* L.	Cucurbitaceae	Herb	3	0.22	DD
20	*Euphorbia hirta* (L.)	Euphorbiaceae	Herb	3	0.22	LC
21	*Acalypha indica* L.	Euphorbiaceae	Herb	1	0.07	LC
22	*Croton lobatus* L.	Euphorbiaceae	Herb	3	0.22	LC
23	*Euphorbia hyssopifolia* L.	Euphorbiaceae	Herb	3	0.22	LC
24	*Euphorbia heterophylla* L.	Euphorbiaceae	Herb	3	0.22	LC
25	*Euphorbia thymifolia* L.	Euphorbiaceae	Herb	3	0.22	LC
26	*Desmodium triflorum* (L). DC	Fabaceae	Creeper	92	6.99	LC
27	*Mimosa pudica* L.C	Fabaceae	Creeper	2	0.15	LC
28	*Desmodium scorpiurus* (SW.) Desv.	Fabaceae	Creeper	2	0.15	LC
29	*Spigelia anthelmia* L.	Loganiaceae	Herb	3	0.22	LC
30	*Boerhavia coccinea* Mill.	Nyctaginaceae	Herb	1	0.07	DD
31	*Oxalis corymbosa* Kunth.	Oxalidaceae	Creeper	11	0.83	LC
32	*Oxalis stricta* L.	Oxalidaceae	Grass	11	0.83	EN
33	*Passiflora foetida* L.	Passifloraceae	Herb	3	0.22	LC
34	*Phyllanthus amarus* Schumach & Thonn.	Phyllanthaceae	Herb	2	0.15	LC
35	*Peperomia pellucida* Kunth.	Piperaceae	Herb	10	0.75	DD
36	*Scoparia dulcis* L.	Plantaginaceae	Herb	2	0.15	LC
37	*Setaria barbata* (Lam.) Kunth	Poaceae	Grass	89	6.76	LC
38	*Imperata cylindrical* (L.) P. Beauv	Poaceae	Grass	265	20.1	LC
39	*Digitaria* sp. (L.)	Poaceae	Grass	176	13.3	LC
40	*Eleusine indica* (L.) Gaertn.	Poaceae	Grass	126	9.57	LC
41	*Panicum maximum* Jacq.	Poaceae	Grass	147	11.1	LC
42	*Dactyloctenium aegyptium* (L.) Willd.	Poaceae	Grass	25	1.89	LC
43	*Aeroceras zizaniodes* (Kunth) Dandy.	Poaceae	Grass	2	0.15	VU
44	*Digitaria sanguinalis* (L.) Scop.	Poaceae	Grass	56	4.25	LC
45	*Pennisetum polystachion* (L.) Schult.	Poaceae	Grass	1	0.07	LC
46	*Axonopus compressus* (SW.) P Beauv.	Poaceae	Grass	118	8.96	LC
47	*Sacciolepis africana* L.E. Hubbard & Snowden.	Poaceae	Herb	2	0.15	LC
48	*Antigonon leptopus* Hook & Arn.	Polygonaceae	Climber	1	0.07	LC
49	*Portulaca quadrifida* L.	Portulaceae	Herb	12	0.91	LC
50	*Portulaca oleracea* L.	Portulaceae	Herb	4	0.30	LC
51	*Oldenlandia corymbosa L.*	Rubiaceae	Herb	11	0.83	LC
52	*Talinum triangulare* (Jacq.) Wild.	Talinaceae	Herb	7	0.53	LC
53	*Laportea aestuans* (L.) Chew	Urticaceae	Herb	3	0.22	LC

This study revealed a complex ecological landscape characterized by varying levels of species diversity and abundance. *Terminalia mantaly,* recorded as the most frequently encountered tree species, reflects its adaptability to urban environments, while its family, Combretaceae, is widely distributed in tropical and subtropical regions, with a diverse habitat of shrubs, lianas, and trees comprising around 23 genera and 600 species (Rahate *et al.,* 2019). This finding is consistent with that of Ajayi et al. (2020), who documented the dominance of *T. mantaly* at Ekiti State University, Ado Ekiti, Nigeria. *Albizia lebbeck* demonstrated the highest Importance Value Index (IVI), suggesting its significant ecological role in the ecosystem. The overall low diversity of tree species, dominated by a select few, raises concerns about ecosystem resilience and highlights the need for conservation efforts to promote greater biodiversity. The presence of endangered species such as *Tectona grandis* and *Irvingia gabonensis* in this urban ecosystem underscores the importance of urban green spaces as potential refugia for threatened flora. However, these species face significant challenges due to human activities, particularly deforestation and irregular tree felling caused by environmental factors, such as wind and thunderstorms. *Commelina erecta* was dominant in the herbaceous layer, while *Imperata cylindrica* showed a widespread distribution. The taxonomic families of the plant species sampled in the study revealed that Fabaceae was the most represented taxonomic family, comprising 13 plant species, Poaceae, followed by 11 plant species, primarily grasses, and Euphorbiaceae, with eight species. Asteraceae, Convolvulaceae, Malvaceae, Combretaceae, Moraceae, Rubiaceae, and Acanthaceae were among the least represented families. This finding aligns with the study by Iheyen *et al.* (2009), who reported that Fabaceae was an abundant family in the Ehor Forest Reserve. Ogwu *et al.* (2016) reported similar findings for the University of Benin, Nigeria, and Moshood et al. (2022) observed this pattern at the University of Ilorin Campus. This prevalence may be attributed to the efficient seed dispersal mechanism of Fabaceae species, as most members of this family are known to disperse their seeds via wind (Ogwu *et al*., 2016) and are distributed globally, with the exception of Antarctica and the high Arctic (Moshood *et al.*, 2022). Furthermore, seeds of the Fabaceae family are encased in pods, facilitating rapid dispersal through animal or human vectors. The Fabaceae family is the third largest taxon of flowering plants globally, following Asteraceae and Orchidaceae, and comprises 770 genera and over 19,500 species (Legume Phylogeny Working Group, 2017).

Analysis of the recorded pollen data from the University of Lagos (UNILAG) yielded significant information on the predominant pollen types and seasonal patterns within the environment. The predominant tree, shrub, and gramineous pollen taxa at the study site reflect the mosaics of lowland and secondary grassland ecotypes, as documented by White (1983). This observation aligns with the findings of Nnamani and Uguru (2013), who reported the prevalence of these species in their research conducted in Nigeria. A total of 5,208 palynomorphs were recovered during the sampling period. This study revealed a greater recovery of pollen and spores in comparison to the work of Ajikah *et al*. (2015), where 3,495 palynomorphs were recovered at the University of Lagos, and Adekanmbi and Ogundipe (2010), where 393 palynomorphs were recovered from the University of Lagos campus. This variation may be attributed to the differences in the height and type of sampler used. The prevalence of arboreal pollen grains depends on the distribution and density of local vegetation and the rate of pollen production. Studies have similarly concluded that the University of Lagos is predominantly characterized by arboreal plants (Adekanmbi & Ogundipe, 2010; Ajikah *et al.*, 2015; Adeniyi *et al.*, 2018). The floral composition of the study demonstrated that the majority of the species surveyed were documented in the pollen record. This observation suggests that plant pollinator interactions in the study area are well represented in the pollen record. The species were effectively represented in the pollen samples, which likely indicates that the surveyed plants contributed significantly to the local pollen record (Alebiosu *et al.*, 2018). This finding is important because it reflects the stability and reliability of the pollen record as a tool for studying plant communities and their pollinators.

Pollen concentrations peaked in March, July, and October, whereas the lowest occurrences were observed in August and September. The primary pollen contributors during the rainy season were *Carica papaya, Elaeis guineensis, Lonchocarpus sericeus, Phyllanthus amarus, Senna siamea, and Senna alata,* whereas the dry season was characterized by the predominance of Poaceae, *Tridax procumbens, Alchornea cordifolia, Bombax buonopozense, Hura crepitans,* and *Asystasia gangetica*. Given that members of the Poaceae family are known allergens (Rodinkova *et al*., 2023; Elshamy *et al*., 2023), individuals with hypersensitivity may consider avoiding July and October, whereas August and September represent periods of lower pollen concentration. The Poaceae family demonstrated the highest abundance throughout the sampling period, which aligns with the findings of Van Haeften *et al*. (2024) and Jetschni and Jochner-Oette (2021), where the Poaceae family similarly dominated in terms of pollen abundance during the same period. The prevalence of Poaceae may be due to the regular weekly clearing of grasses coupled with higher wind speeds. Moreover, the list of species in the Poaceae family that can cause allergies is constantly expanding, and currently includes the pollen of 21 types of grasses (Allergy & Autoimmune disease, 2023).

The recovery of *Alchornea cordifolia* pollen during the dry or Harmattan season, which occurs between December and April, is in agreement with the findings of Essien and Agwu (2013), who reported that pollen types of A. *cordifolia, Elaeis guineensis*, Poaceae, among others, were dominant in the Anyigba, Kogi State. This period is marked by specific climatic conditions, including reduced rainfall and increased atmospheric dust, which are characteristic of harmattan winds (Adeniyi *et al*., 2024). This plant species, commonly found in freshwater swamps, canals, wetlands, secondary forests, and riverine forests, is the dominant species in these ecosystems (Adekanmbi *et al.*, 2023). A. *cordifolia* is known for its high allergenicity, with its pollen protein exhibiting an 84% allergenicity rate (Adeniyi *et al.*, 2018). This poses substantial health risks for individuals with hypersensitivity, particularly those living in close proximity to the plant's habitats. This risk is further amplified by the plant's prolific pollen production and the ability of the pollen to remain airborne throughout the year. The abundance of

Elaeis guineensis pollen in the environment has been well documented, with studies such as Njokuocha (2006) highlighting its preponderance among anemophilous (wind-dispersed) pollen types. The species demonstrated the highest pollen abundance from May to October, which coincides with the primary flowering season (Essien, 2019). This peak in pollen production is likely influenced by various environmental factors, such as temperature, rainfall, and day length, which are optimal for the reproductive processes of plants during these months. Following this maximum pollen abundance period, there was a noticeable decline in pollen production from November to March. Although pollen levels were lower during this time, they still maintained a secondary, less pronounced peak. This cyclical pattern of pollen production is crucial for the reproductive success of plants, and has significant implications for both natural ecosystems and agricultural practices (Musta & Ianovici, 2025).

The recovery of fungal spores, such as *Glomus* sp., was found to exhibit the highest abundance, particularly in May, June, and September. This observation suggests that *Glomus* sp. demonstrated peak activity during these months, likely corresponding to environmental conditions conducive to its growth, such as elevated soil moisture and high relative humidity resulting from substantial precipitation during this period (Chaudhary *et al.,* 2020). This study aligns with the findings of Walter *et al.* (2023), who also reported the presence of this species in the same geographical area in Nigeria. The prevalence of *Spegazzinia tesarthra* and *Helminthosporium maydis* spores in the air, particularly in May, June, and March, provides valuable insights into local agricultural practices and potential plant health concerns. These fungal species are closely associated with maize cultivation (Rahman *et al.,* 2023; Bharti *et al.,* 2020), which aligns with the ongoing farming activities near the study area. The consistent recovery of these spores over multiple months suggests a sustained presence of maize crops and highlights the potential for year-round fungal activity in the study area. The presence of insect parts fluctuated with significant increases in August and February, which could reflect seasonal changes in insect activity. This seasonal pattern may be influenced by factors such as temperature, humidity, and daylight hours, which can affect insect population and behavior. The August peak could correspond to the abundance of insects, whereas the February increase might be related to the emergence of certain species. This study agrees with the conclusions drawn by Kemabonta *et al.* (2018), specifically their observation that insect parts were recovered more frequently in the dry season than in the wet season. Zooplankton populations showed a generally steady but low presence throughout the sampling period, with small upticks in May, November, and January. These slight increases could be linked to seasonal factors such as changes in water temperature and nutrient levels. The absence of sharp peaks suggests a stable ecosystem with no major fluctuations in the zooplankton abundance. Additionally, the remains of zooplankton ephippia can offer insights into broader ecosystem changes, including changes in fish population dynamics and macrophyte density (Bennion *et al.,* 2018). Plant fragments demonstrated a significant peak in January, potentially indicating the seasonal shedding of vegetation or increased plant material input into the atmosphere. This could be due to factors such as the increased wind speed as a result of harmattan. *Nephrolepis biserrata,* a fern species, was significantly present in September, suggesting a possible seasonal bloom or favorable environmental conditions for its growth during this period. The peak months of fern spore load in the atmosphere of the study area are in contrast to the findings of Adekanmbi and Alebiosu (2018), who reported greater quantities of airborne fern spores in July and January. In this study, the representation of N. *biserrata* and *Pteris* sp. reflected the presence of a freshwater swamp forest in which the parent plants were situated in proximity to the study sites.

The diatom frustule wall showed consistent presence throughout the year, with significant peaks observed in May and January. These findings are consistent with observations by Essien (2019), who noted that diatoms are commonly associated with dry ponds, seasonally flooded areas experiencing drying, and loose dry soils, all of which provide suitable habitats for these algae. He further highlighted that during extended periods of dryness in the Akoko environment, ponds and waterlogged areas dry up, exposing freshwater algae, particularly diatoms, to dust storms and strong harmattan winds. The increased presence of freshwater diatom frustules in the air spora of the study area served as a significant indicator of two key factors. First, it suggests an increase in overall dryness in the area. Second, it points to the arrival of materials transported over long distances by northeast (NE) trade winds, commonly referred to as Harmattan. This phenomenon not only demonstrates the impact of local environmental conditions on the presence of diatoms but also highlights the role of regional wind patterns in the distribution of these microscopic algae. The seasonal peaks observed in May and January further emphasize the cyclical nature of these environmental influences on the presence of diatoms in the air spora.

The observation of rising temperatures during the dry season (October–April) and lower values during the rainy season mirrors the typical West African monsoonal climate. This pattern is consistent with findings by Salami et al. (2025), who noted higher temperatures during the Harmattan season due to clear skies and increased solar radiation, and a cooling effect during the wet season due to cloud cover and rainfall. This pattern aligns with the double maxima rainfall regime often observed in southern Nigeria, where the first peak typically occurs around June–July (Salami *et al.,* 2025). The July peak is associated with the northward movement of the Inter-Tropical

Convergence Zone (ITCZ). The relatively stable RH (74–87%) could be attributed to proximity to water bodies and persistent cloud cover. This stability has been noted in regions with dense vegetation or coastal influence, such as in studies by Akpabio et al. (2010) on Nigeria's Niger Delta. Elevated wind speeds in August and February may correspond to the transition periods in the West African monsoon system, with stronger Harmattan winds (dry northeasterlies) typically observed in February. Kebacho *et al.* (2025) also reported similar peaks in wind activity during these months in northern Nigeria.

The positive relationship suggests that warmer, drier, and windier conditions favor pollen dispersal and preservation. This is supported by Naseer *et al.* (2024), who observed increased pollen concentration in air samples during dry, warm, and windy conditions in both tropical and temperate zones. Wind promotes airborne dispersal, while low humidity reduces pollen clumping or washout by rain. Rain tends to wash pollen from the air, and high humidity can cause pollen grains to rupture or deteriorate, reducing airborne counts (Naseer *et al.,* 2024). Thus, lower pollen presence in wet months is a common trend. Fungal spores, particularly from species like *Cladosporium* and *Alternaria,* thrive under moist conditions and often increase during wet periods (Bhushan *et al.,* 2025). The humid environment facilitates fungal growth and spore release. High temperatures and wind can desiccate fungal sources or hinder spore survival (Valle *et al.,* 2024). Studies by Hayoun *et al.* (2024) observed declines in fungal spores during hot, dry, and windy conditions.

CONCLUSIONS

This study provides valuable insights into the local aeroflora and identifies potential allergy seasons based on the identified pollen types. This revealed a complex ecological landscape characterized by varying levels of species diversity and abundance. *Terminalia mantaly* was recorded as the most frequently encountered tree species, reflecting its adaptability to urban environments. The overall low diversity of tree species, dominated by a select few, raises concerns about the ecosystem's resilience and highlights the need for conservation efforts to promote greater biodiversity. The prevalence of Poaceae pollen throughout the sampling period suggests that individuals with hypersensitivity may consider avoiding July and October, whereas August and September represent periods of lower pollen concentration. The recovery of *Alchornea cordifolia* pollen during the dry or Harmattan season poses substantial health risks for individuals with hypersensitivity, particularly those living in close proximity to the plant's habitats. The recovery of fungal spores of *Glomus* sp., *Spegazzinia tesarthra,* and

Helminthosporium maydis provides valuable insights into local agricultural practices and potential plant health concerns.

Acknowledgement. The authors gratefully acknowledge the support of the Department of Botany, University of Lagos, for providing laboratory space and technical assistance during the course of this study. We also thank the staff and students of the University of Lagos for their cooperation during fieldwork and sampling activities.

Funding Declaration. This research was funded by the **Lagos State Science Research and Innovation Council (LASRIC)** under its Science Research Grant scheme 2022.

REFERENCES

- Adekanmbi, O. H., Ogundipe, O. T. 2010. Aeropalynological studies of the University of Lagos campus, Nigeria. *Notulae Scientia Biologicae*, *2*(4), 34-39. https://doi.org/10.15835/nsb245393
- Adekanmbi, O. H., Ogundipe, T. O., Walter, O. J. 2021. Pollen: A silent witness in forensic investigations of crime. *Journal of Scientific Research and Development*, *20*(1), 1-15.
- Adekanmbi, O. H., Walter, O. J., Ikegbunam, N. C., Afolabi, F. T. 2023. Changes in Vegetation in Relation to Human Activities in Atlas Cove, Lagos, Nigeria. *Journal of Tropical Resources and Sustainable Science (JTRSS)*, *11*(1), 55-63.
- Adeniyi, M. J., Fabunmi, O. A., Awosika, A. 2024. Unravelling the interplay between Harmattan wind and baroreflex functions: implications on environmental health and cardiovascular pathophysiology. *Exploration of Medicine*, 5(5), 584-600.
- Adeniyi, T. A., Adeonipekun, P. A., Olowokudejo, J. D., Akande, I. 2018. Allergenicity of dominant aeropollen in Nigeria (part II). *Current Allergy & Clinical Immunology*, 31(3), 178-183.
- Ajayi, I. K., Kayode, J., Ademiluy, B. O. 2020. Study on urban trees in Ekiti State University, Ado Ekiti, Nigeria: 1. structure and composition. *Budapest International Research in Exact Sciences (BirEx) Journal,* 2(2), 147-156.
- Ajikah, L. B., Neumann, F. H., Alebiosu, O. S., Bamford, M., Ogundipe, O. T. 2021. Relevance of aerobiological studies in Nigeria: a two-year aerospora record of Lagos. *Aerobiologia*, *37*(3), 597-613. https://doi.org/10.1007/s10453-021-09717-0
- Ajikah, L., Neumann, F. H., Berman, D., Peter, J. 2020. Aerobiology in South Africa: A new hope! *South African Journal of Science*, *116*(7-8), 1-4. https://doi.org/10.17159/sajs.2020/8347
- Ajikah, L., Ogundipe, O., Bamgboye, O. 2015. Palynological survey of air-borne pollen and spores in the University of Lagos, Akoka Campus, Southwestern Nigeria. *Ife Journal of Science*, *17*(3), 643-655.
- Akobundu I. O., Agyakwa, C. W. 1998. A Handbook of West African Weeds. IITA, Ibadan, Nigeria, 2nd Edition, pp 194-195.
- Akpınar, S., Altunoğlu, M. K. 2024. Determination of Atmospheric Pollen Grains by Volumetric Method in Sarıkamış District (Kars-Türkiye). *Biology,* 13(7), 475. https://doi.org/10.3390/biology13070475
- Alebiosu, O. S., Adekanmbi, O. H. 2018. A survey of atmospheric pollen and spores in North-Western Nigeria. *Notulae Scientia Biologicae*, *10*(2), 182-192. https://doi.org/10.15835/nsb10211213
- Alebiosu, O. S., Adekanmbi, O. H., Nodza, G. I., Ogundipe, O. T. 2018. Aeropalynological study of two selected locations in North-Central Nigeria. *Aerobiologia*, *34*, 187-202. https://doi.org/10.1007/s10453-017-9513-3
- Allergy & Autoimmune disease. The Allergen Encyclopedia. Accessed 2 July 2023. https://www.thermofisher.com/diagnostic-education/hcp/wo/en/resource-center/allergen-encyclopedia.html
- Bennion, H., Sayer, C. D., Clarke, S. J., Davidson, T. A., Rose, N. L., Goldsmith, B., Wiik, E. 2018. Sedimentary macrofossil records reveal ecological change in English lakes: implications for conservation. *Journal of Paleolimnology*, *60*, 329-348. https://doi.org/10.1007/s10933-018-0021-9
- Bharti, P., Chand, P., Gupta, P. K. 2020. Effective chemical protection against Maydis Leaf Blight of Maize incited by Helminthosporium maydis under the in-vitro and in-vivo condition. IJCS, 8(3), 742-748

- Bhushan, B. T., Alam, S. H., Mahapatra, S., Chakraborty, S., Hooi, A. 2025. Alternaria. In *Compendium of Phytopathogenic Microbes in Agro-Ecology: Vol. 1 Fungi* (pp. 1-21). Cham: Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-04265-2_120-1
- Buters, J. T., Antunes, C., Galveias, A., Bergmann, K. C., Thibaudon, M., Galán, C., Oteros, J. 2018. Pollen and spore monitoring in the world. *Clinical and translational allergy*, *8*, 1-5. https://doi.org/10.1186/s13601-018-0197-1
- Chaudhary, V. B., Nolimal, S., Sosa-Hernández, M. A., Egan, C., Kastens, J. 2020. Trait-based aerial dispersal of arbuscular mycorrhizal fungi. *New Phytologist*, 228(1), 238-252. https://doi.org/10.1111/nph.16642
- Ciobanu, D-G, Ianovici, N. 2024. Overview of allergies with focus on causative agents, cross-reactivity, diagnostic methods and immunotherapy. *Research Journal of Agricultural Science*, 56 (2): 31-39
- Cristofolini, F., Cristofori, A., Corradini, S., Gottardini, E. 2024. The impact of temperature on increased airborne pollen and earlier onset of the pollen season in Trentino, Northern Italy. *Regional Environmental Change*, 24(2), 1-13. https://doi.org/10.1007/s10113-024-02290-z
- Elshamy, H., Abdel-Ghaffar, A. R. B., Elwan, Z. A. 2023. Identification of Some Allergenic Pollen Proteins of Some Fabaceae and Poaceae Species using SDS-PAGE Technique. *Egyptian Journal of Pure and Applied Science*, 61(2), 28-41. https://doi.org/10.21608/ejaps.2023.196823.1056
- Essien, B. C. 2019. The Environmental, Ecological and Medical Impact of Airborne Pollen Grains, Spores of Fungi and Pteridophyte and Other Atmospheric Palynomorphs in Akoko Division, Ondo State, Nigeria. Nigeria. *Journal of Biotechnology and Biochemistry*, 5(5), 08-17.
- Essien, B. C., Agwu, C. O. C. 2013. Aeropalynological study of Anyigba, Kogi State, Nigeria. *Standard Scientific Research and Essays*, *1*(13), 347-351.
- Grimm, E.C. 2013. Tilia. Illinois State Museum, Springfield, Illinois, USA. Version 2.0.4.
- Hammer, O., Harper, D. A., Ryan, P. D. 2001. PAST: Paleontological statistics software package for education and data analysis. *Palaeontologia Electronica, 4*(1), 9.
- Hayoun, I., El Haskouri, F., Bouziane, H. 2024. Airborne fungal spores in Tétouan (NW of Morocco), sporal calendar and meteorogical parameters. *Revue Française d'Allergologie*, 64(6), 104146. https://doi.org/10.1016/j.reval.2024.104146
- Ianovici, N., Tudorică, D., Șteflea, F. 2015. Methods of biomonitoring in urban environment: allergenic pollen in Western Romania and relationships with meteorological variables. *Annals of West University of Timişoara, ser. Biology*, 18 (2): 145-158.
- Iheyen, J., Okoegwale, E.E., Menshak, J. 2009. Timber Resources Status of Ehor Forest Reserve Uhunmwode Local Government Area of Edo State, Nigeria. *Nature and Science Journal,* 7(8): 19-25.
- IPNI 2024. International Plant Names Index. Published on the Internet http://www.ipni.org,
- IUCN 2022. The IUCN Red List of Threatened Species. Version 2022-2. https://www.iucnredlist.org. [Accessed 15 March, 2024].
- Jetschni, J., Jochner-Oette, S. 2021. Spatial and temporal variations of airborne Poaceae pollen along an urbanization gradient assessed by different types of pollen traps. *Atmosphere,* 12(8), 974. https://doi.org/10.3390/atmos12080974
- Kebacho, L. L., Hamadalnel, M., Ragab, A. 2025. Modulation of the West African monsoon and the tropical easterly jet on Sudan rainfall by La Niña during the 2007 summer. *Arabian Journal of Geosciences*, *18*(3), 71. https://doi.org/10.1007/s12517-025-07071-0
- Kemabonta, K. A., Adeonipekun, P. A., Adebayo, M. B., Anumudu, P., Adeniyi, T. A. 2018. Aerobiology of insect parts in Ayetoro, Ota, South west, Nigeria. Annales of West University of Timisoara. *Series of Biology,* 21(1), 57-66.
- Legume Phylogeny Working Group 2017. *Taxon*, 66 44–77. https://doi.org/10.12705/661.3
- Moshood. F.J., Ibrahim, T.M., Salami, K.D. 2022. Stability Assessment of Tree Species in the University of Ilorin Permanent Site, Nigeria. *FUW Trends in Science and Technology Journal,* 7(1): 370-378.
- Mueller-Dombois, D. 1972. Crown distortion and elephant distribution in the woody vegetations of Ruhuna National Park, Ceylon. *Ecology*, *53*(2), 208-226. https://doi.org/10.2307/1934629
- Musta, NT, Ianovici, N. 2025. An investigative case study on allergen spectrum among patients in Western Romania. *Research Journal of Agricultural Science*, 57 (2), http://doi.org/10.59463/RJAS.2025.2.13

- Naseer, S., Noor, M. J., Iftikhar, S. 2024. Airborne pollen and spore monitoring for seasonal trends and dynamic interconnection with meteorological parameters in Rawalpindi city, Pakistan. *Atmospheric Environment*, *336*, 120755. https://doi.org/10.1016/j.atmosenv.2024.120755
- Njokuocha, R. C. 2006. Airborne pollen grains in Nsukka, Nigeria. *Grana*, *45*(1), 73-80. https://doi.org/10.1080/00173130600561612
- Nnamani, C. V., Uguru, A. N. 2013. Diversity of honey producing plants in Southern Nigeria: Basic Pre-requisite for conservation and sustainability. *Journal of Sustainability Science and Management*, *8*(1), 103-112.
- Ogunyebi, A. L., Abiodun, M. J., Oludoye, O. O., Omoyajowo, K. O., Fayenuwo, G. A., Fingesi, T. S. 2018. Assessment of tree species diversity in the University of Lagos, Akoka, Lagos. *Journal of Applied Sciences and Environmental Management,* 22(1): 12-16. https://doi.org/10.4314/jasem.v22i1.2
- Ogwu, M.C., Osawaru, M.E. & Obayuwana, O.K. 2016. Diversity and Abundance of Tree Species in the University of Benin, Benin City, Nigeria. *Applied Tropical Agriculture,* 21(3): 46-54.
- Omomoh, B., Adekunle, V., Lawal, A., & Akinbi, O. 2019. Tree species diversity and regeneration potential of soil seed bank in Akure forest reserve, Ondo State, Nigeria. *Taiwania, 64*(4), 409-416. https://doi.org/10.6165/tai.2019.64.409
- Ozoh, O. B., Aderibigbe, S. A., Ayuk, A. C., Desalu, O. O., Oridota, O. E., Olufemi, O., Dede, S. K. 2019. The prevalence of asthma and allergic rhinitis in Nigeria: A nationwide survey among children, adolescents and adults. *PloS one*, *14*(9), e0222281. https://doi.org/10.1371/journal.pone.0222281
- Rahate, S., Hemke, A., Umekar, M. 2019. Review on Combretaceae family. *International Journal of Pharmaceutical Sciences Review and Research,* (2), 22-29.
- Rahman, V., Meena, K. R., Al-Ani, L. K. T., Singh, A., Kumar, A. 2023. Bacillus velezensis strain improvement to control *Helminthosporium maydis* causing southern corn leaf blight disease in maize. *European Journal of Plant Pathology*, 167(3), 301-313. https://doi.org/10.1007/s10658-023-02729-1
- Rodinkova, V., Yuriev, S., Mokin, V., Sharikadze, O., Kryzhanovskyi, Y., Kremenska, L., Kurchenko, A. 2023. Sensitization patterns to Poaceae pollen indicates a hierarchy in allergens and a lead of tropical grasses. *Clinical and Translational Allergy,* 13(8), e12287. https://doi.org/10.1002/clt2.12287
- Salami, A. A., Olanrewaju, R. M., Bakare, K. O., Babatunde, O. R. 2025. Spatial distribution of rainfall in Nigeria. *Arabian Journal of Geosciences*, *18*(1), 1-25. https://doi.org/10.1007/s12517-024-12512-3
- The Royal Botanic Gardens, Kew, Harvard University Herbaria & Libraries and Australian National Herbarium. [Retrieved 10 March, 2024].
- Valle, D. I. R., Medina, E. Y. G., Zeballos, O. A. 2024. Airborne fungal concentrations around the Modelo Callao Landfill. *Heliyon*, *10*(20). https://doi.org/10.1016/j.heliyon.2024.e12076
- Van Haeften, S., Campbell, B. C., Milic, A., Addison-Smith, E., Al Kouba, J., Huete, A., Davies, J. M. 2024. Environmental DNA analysis of airborne poaceae (grass) pollen reveals taxonomic diversity across seasons and climate zones. *Environmental Research,* 247, 117983. https://doi.org/10.1016/j.envres.2024.117983
- Walter, O. J., Adekanmbi, O. H., Onuminya, T. O., Olowokudejo, J. D. 2023. Evaluation of Pollen Grains and Spores Potential in Revealing Vehicle Travel History on the Ife-Ondo Road, Southwestern Nigeria. *Journal of Applied Sciences and Environmental Management*, 27(8):1817-1823. https://doi.org/10.4314/jasem.v27i8.23
- Walter, O. J., Onuminya, T. O., Ikegbunam, N. C., Olowokudejo, J. D. 2025. Characterization of Plant Species and Their Associated Pollen Signatures Along the Ijesa-Akure Road. *Palynology,* (1-13), 2491765. https://doi.org/10.1080/01916122.2025.2491765
- White, P. S. 1983. Corner's rules in eastern deciduous trees: allometry and its implications for the adaptive architecture of trees. *Bulletin of the Torrey Botanical Club*, 203-212. https://doi.org/10.2307/2996596
- Zhang, J., Yan, Y., Jiang, F., Chen, J., Ouyang, Y., Zhang, L. 2024. Main Airborne Pollen Species and Characteristics of Allergic Rhinitis Patients with Pollen-Related Allergies in 13 Northern Chinese Cities. *Journal of Asthma and Allergy,* 757-768. https://doi.org/10.2147/JAA.S402999