https://dx.doi.org/10.4314/ijs.v24i1.4
Ife Journal of Science vol. 24, no. 1 (2022)

PALYNOLOGICAL INVESTIGATION OF CRIMES IN LAGOS, NIGERIA

Adekanmbi, O. H.*, Ogundipe, O. T., Okwong, J. W.
Department of Botany, Faculty of Science, University of Lagos, Akoka, Lagos, Nigeria
*Corresponding Author's Email: helen_olu@yahoo.com
(Received: 20th June, 2021; Accepted: 25th January, 2022)

ABSTRACT

Pollen grains and spores were deployed for the investigation of criminal cases, at the University of Lagos, Akoka, with proof and disproving of alibis. Evidence was retrieved from suspects' shoes, earlobes, nostrils and clothing using pinch method. The recovered evidences were subjected to standard forensic laboratory procedures. A total of 23 palynomorphs belonging to 13 families were recorded from evidences obtained from the suspects and crime scenes for the four criminal cases analyzed. The criminal case codes are Akoka 001, Akoka 002, Akoka 003 and Akoka 004. Investigations revealed pollen of open forest types: *Terminalia mantaly*, *Hura crepitans, Bougainvillea glabra. Hewittia sublobata*, *Indigofera spicata*, *Commelina benghalensis. Amaranthus spinosus, Zea mays*, *Alchornea cordifolia, Tridax procumbens*, *Vernonia cinera* among others, were also represented. They were found to be dominant for both evidences retrieved from suspects and crime scenes. Some plants in the immediate vegetation contributed to the pollen assemblage of the crime scenes. The retrieved palynomorphs were able to link the suspects to crime scenes due to the strong relationship between the palynomorphs and extant plants present in the crime scenes.

Keywords: Forensic, Pollen, Spores, Crime, Investigation, Nigeria.

INTRODUCTION

In Nigeria, significant numbers of criminals have cheated the justice system by escaping punishment due to incomplete or incompetent criminal investigations, leading to insufficient evidence upon which the courts can establish a conviction. The challenges facing security agencies have been linking suspects to a crime scene (Walter *et al.,* 2019). The lack of capacity of the security agencies in criminal investigations has led to a methodological shift in investigative techniques, from a holistic approach of sourcing, analyzing, and interpreting evidence, to the drive to obtain confessional statements by all means from suspected persons. This trend has led to the use of force and torture techniques by security agencies. The consequence of this is that virtually all confessional statements are challenged during prosecutions on grounds of police coercion. The security agencies are still neophytes in the use of biological evidence for criminal investigation. Their inability to examine biological evidence led to prison congestion in Nigeria, due to a lack of evidence to prosecute the suspects.

Palynology is the study of pollen grains and spores. Pollen contains the male reproductive material of cone-bearing (gymnosperms) and flowering (angiosperms) plants and spores are the asexual reproductive propagules of ferns, fungi, and mosses (Horrocks and Walsh, 2001; Milne *et al.,* 2005). Each species of the plant produces either pollen or spores that have a unique morphology that can be used to identify plants to a family, genus, or species level (Erdtman, 1969; Moore and Webb, 1978; Mildenhall, 1990; Mildenhall *et al.,* 2006). The pollen produced by plants are microscopic in size, acid-resistant, unique to a particular species, and can be produced in vast numbers (Milne *et al.,* 2005; Mildenhall, 2006). Wind dispersed pollen can be found everywhere and is one of the components of dust and soil. Being microscopic in size, pollen can be transferred from one object to another without being visible to the human eye (Mildenhall *et al.,* 2006).

Forensic palynology is the use of pollen and spores in criminal investigations (Bryant and Mildenhall, 1998; Horrocks and Walsh, 1998; Horrocks and Walsh, 1999; Milne *et al.,* 2005) and uses the comparison of samples obtained from crime scenes/victims/accused, to prove or disprove an alleged event (Mildenhall, 2006). It is based on Locards Exchange Principle which states that 'Every contact leaves a trace' (Horrocks and Walsh, 1998; Mildenhall, 1998; Riding *et al.,* 2007). It is most useful as corroborative evidence and has been used in some cases to convict a suspect. It compares evidentiary samples (i.e., clothing,

shoes, cars, implements from suspects and victims) to control samples from crime scenes to determine if there is a link between them. It can be used as associative, corroborative evidence (Mildenhall *et al.,* 2006). It has been used to determine an alleged location of an event.

There are numerous cases cited where sexual assaults have been committed, and there has been a discrepancy as to the location of the alleged assault (Horrocks and Walsh, 1999; Mildenhall, 2006). Forensic palynology has been used to confirm the location a complainant alleges that the assault took place. Drugs can be traced back to where they were grown, manufactured, and/or packaged by analyzing their pollen contents (Mildenhall, 1990). It has also been used to help estimate the time of death of an individual. By analyzing the contents of a deceased's stomach, it is possible to ascertain what food they may have ingested before death, and how long before death those foods were ingested given the rate of digestion (Miller-Coyle *et al.,* 2001). It is also possible to indicate the season of the death of a person (Wiltshire, 2006). This is possible by identifying pollen and/or spores found in the stomach contents of a victim, and by identifying each species and the time these plants flower (Mildenhall *et al.,* 2006; Wiltshire, 2006). In Nigeria, it has been used in proving or disproving an alibi (Walter *et al.,* 2019). This study aims to assess the feasibility of pollen and spores as associative evidence recovered from suspects linked with a crime scene.

MATERIALS AND METHODS

Description of the study area

The study location is situated at the University of Lagos, Akoka, Yaba, Lagos and lies between Latitude 6°31'0.70"N and Longitude 3°23'57.76"E (Figure 1). The University of Lagos is located on the western part of Lagos metropolis in Yaba Local Government Area of the state.

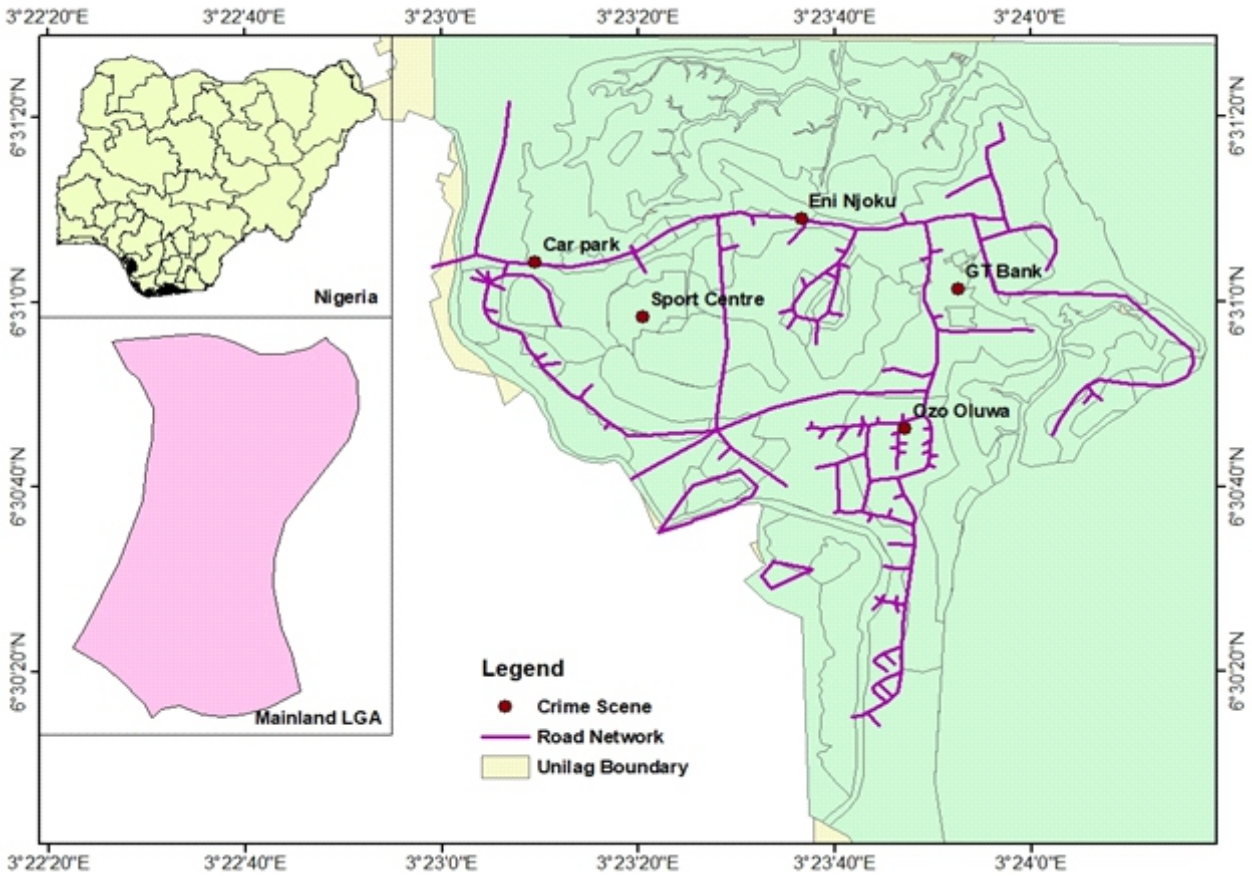

Figure 1: Map showing the crime scenes at the University of Lagos, Nigeria

Evaluation of Crime Scene

The crime scenes were evaluated before anybody could gain access, which was a way of keeping evidence intact. The examination of the scenes begins with a walk through the area along the "trail" of the crime. The trail was marked by the presence of physical evidence. This includes the point of entry, the location of the crime, areas where a suspect may have cleaned up, and the point of exit. The crime scenes were documented with photographs and sketches.

Plant enumeration

This involved a qualitative enumeration of plants in the surrounding vegetation using a 50 x 20 m plot for tree species and a quadrat of 0.5 x 2 m plot for both herbs and grasses. Samples were collected randomly within each plot, and plants were identified with the aid of keys, as described previously (Hutchinson and Dalziel 1954, Keay 1959; Keay *et al.,* 1964). The present vegetation of the crime scenes is predominantly an open vegetation, consisting of *Hewittia sublobata, Panicum maximum, Alchornea cordifolia, Tridax procumbens, Terminalia catappa, Terminalia mantaly, Elaeis guineensis, Chromolaena odorata, Gomphrena celosoides, Mariscus alternifolius and Paspalum vaginatum.* Other represented plants include *Triumffeta cordifolia, Phyllantus* sp., *Drepanocarpus lunatus, Mimosa pudica, Luffa cylindrica, Saccolepis africana, Scoparia dulcis, Dalbergia castaphyllum, Vernonia cinera, Ficus* sp., *Alternanthera sessilis, Ipomea carica* and *Vernonia amygdalina* among others.

Pollen type identification and nomenclature:

Identification of palynomorphs was achieved by using reference slides in Palynology and Palaeobotany laboratory, Department of Botany, University of Lagos, Akoka, Lagos. Similarly, palynomorphs were identified as described by Gosling *et al.* (2013); Gelorini *et al.* (2011) and Demske *et al.* (2013). Those grains that could not be identified at all due to limited human knowledge were listed as unidentifiable.

Case Background and Crime Scene

1. Akoka 001

Suspects A and B (20 and 21 years of age) were apprehended at the University of Lagos at 11:05 a.m. They were accused of stealing a (Tecno Spark 4) phone from a 200-level student of Human Kinetic and Health Education Department at the University of Lagos, while on their way to the main campus. When the victim alighted from the cab in which he and the suspects boarded, he said he couldn't find his phone. So, he went on the hunt for the suspects, and thankfully for him, he found them lurking among the students at Guaranty Trust Bank on the Unilag campus. The suspects got into another cab heading to the first gate, where the victim called the security personnel and they were arrested. Despite the fact that one of the suspects was apprehended with the phone at the first gate, he denied that he saw the phone on the ground, and that he was never in the cab as the victim claimed.

Figure 2: (A) Crime scene (B) Entrance of suspects hideout (C) Hideout of suspects

II Akoka 002

Suspect C, an 11-year-old boy, was alleged to have stolen Tecno Camon 12 in Sports Center at the University of Lagos from someone else's bag at 5.55pm. The victim claimed that because the accused was a young individual, he had no reason to suspect him until the phone was discovered in his hands. The suspect admitted that he was never at the location where the bag was kept, but that he discovered the phone on the ground and was about to take it to Bariga to sell it when he was apprehended by the security officers.

Figure 3: (A) Crime scene (B) Main gate to the crime scene

III Akoka 003

On the 12th of February 2020, a 24-year-old man was detained in Ozoluwa at 11 a.m. In a concealed area utilized as a kitchen in an apartment, he was suspected of utilizing heavy drugs. His presence seemed questionable because he wasn't a student, and the lecturer he claimed to have come to see was not present. All of the allegations were refuted by the suspect.

Figure 4: (A) Crime scene (B) Entrance to the crime scene

IV Akoka 004

A 17-year-old 200-level student of the Department of Science and Technology, Faculty of Education, University of Lagos, allegedly broke into room F 203 of Njokwu Hall of Residence to steal an iPhone 6 and a laptop at about 11 p.m. The victim claimed that the suspect was seen peeping into their room at unusual hours. The accused refuted the allegation claiming he was never present in that hall on the day of the occurrence. He was not found with the stolen item.

Collection of evidence

Experimental samples were collected from suspect's shoes, clothes, nostrils, and auricles using vacuum extractor and cotton bud, while the control samples were also collected using the "pinch method." This was accomplished by selecting a 1 to 4 meter square area and strolling back and forth across the crime scene, collecting pinches of soil. Each pinch of dirt was blended and wrapped in a single, sterile plastic bag. All pinches of dirt were blended to eliminate the risk of over-representation of a single pollen type. In most situations, more than eight pinches of dirt are required for each control sample before their combined soil gives a reliable pollen assemblage of the regional flora, (Walter *et al.,* 2019). In most cases, 10 to 20 pinches of soil per control sampling area were sufficient to ensure a reliable sample.

Laboratory Analysis

Two grams of each sample were prepared for pollen analysis in the Palynology and Palaeobotany Laboratory, Department of Botany, University of Lagos, Akoka, Lagos, Nigeria. Pollen extraction followed a standard modified method from Erdtman (1969) which involves subjecting the sediment to both mechanical and chemical analysis. Mechanical procedures include wet sieving for eliminating small silt size and sand fractions and/or dense liquid separation. Chemical procedures consist of Hydrochloric acid (HCl) and Hydrofluoric acid (HF) maceration to dissolve carbonate and silica particles. This also includes the treatment with acetic anhydride and Sulfuric acid to eliminate the labile organic matter. The techniques were aimed largely at removing the non-pollen materials in the sediment and concentrating the palynomorphs as much as possible. Samples were stored using 100% glycerine to prevent the palynomorphs from drying out. Slides were prepared for quantitative and qualitative microscopic analysis. The prepared slides were studied i.e. scanned and counted, with the light microscope using (x40) objective lens, and photomicrographs of selected palynomorphs were taken with a Moticam 2300.

RESULTS

The palynological analysis revealed a total of 23 palynomorphs (pollen and spores) belonging to 13 families from evidences obtained from both the suspects (experimental) and crime scenes (control). The crime scenes are situated in Akoka (University of Lagos) (Figures 2, 3 and 4). The criminal cases code are: Akoka 001, Akoka 002, Akoka 003 and Akoka 004. The frequency and percentage composition of the recovered palynomorphs for both experimental and control evidences for Akoka (001) to Akoka (004) are recorded in Table 1. Graphical representation is also displayed in Figures 5, 6, 7 and 8.

In Akoka (001) criminal case, the dominant palynomorphs include *Terminalia mantaly* H. Perrier (29.2%, 35.7%), *Hura crepitans* L. (12.5%, 9.5%) and *Bougainvillea glabra* (8.3%, 14.3%) for both the suspects (experimental) and crime scenes (control), respectively. Akoka (002) criminal case for both experimental and control comprises *Hewittia sublobata* (L.f.) O. Ktze. (15.4%, 22.9%), *Indigofera spicata* L. (23.1%, 25.0%), *Commelina benghalensis* (11.5%, 8.3%), *Tridax procumbens* L. (7.7%, 10.4%) and *Amaranthus spinosus* L. (7.7%, 14.5%). The recovered palynomorphs which are dominant in both samples examined for Akoka (003) criminal case are *Amaranthus spinosus* L. (14.3%, 17.1%), *Zea mays* L. (14.3%, 14.3%), *Alchornea cordifolia* Schum. & Thonn. (14.3%, 8.6%), *Tridax procumbens* L. (7.1%, 14.3%) and *Cynodan dactylon* (L.) Pers. (14.3%, 14.3%). The palynological analysis for Akoka (004) criminal case revealed that *Zea mays* L. (11.1%, 12%), *Tridax procumbens* L. (11.1%, 32%), *Vernonia cinera* L. (11.1%, 8%), *Amaranthus spinosus* L. (11.1%, 12%), *Gomphrena celosioides* Mart. (11.1%, 20%) and *Paspalum vaginatum* Sw. (11.1%, 8%) were all dominant in both experimental (suspect) and control (crime scenes) samples, respectively.

Table 1: Showing the Percentage Composition of Recovered Palynomorphs across the Crime Scenes in Akoka

S.N	Plant Taxa	Crime code / Family	AKOKA 001 001 Exp.	AKOKA 001 001 Con.	AKOKA 002 002 Exp.	AKOKA 002 002 Con.	AKOKA 003 003 Exp.	AKOKA 003 003 Con.	AKOKA 004 004 Exp	AKOKA 004 004 Con.
1.	*Gomphrena celosioides* Mart.	Amaranthaceae	4.2	9.5	7.7	2.1	0	8.6	11.1	20
2.	*Amaranthus spinosus* L.	Amaranthaceae	0	0	7.7	14.5	14.3	17.1	11.1	12
3.	*Vernonia cinera* L.	Asteraceae	0	0	7.7	6.2	7.1	2.8	11.1	8
4.	*Tridax procumbens* L.	Asteraceae	0	0	7.7	10.4	7.1	14.3	11.1	32
5.	*Terminalia catappa* L.	Combretaceae	4.2	4.7	0	0	0	0	0	0
6.	*Terminalia mantaly* H. Perrier	Combretaceae	29.2	35.7	0	0	0	0	0	0
7.	*Commelina benghalensis* L.	Commelinaceae	0	0	11.5	8.3	7.1	5.7	0	0
8.	*Hewittia sublobata* (L.f.) O. Ktze.	Convovulaceae	0	0	15.4	22.9	0	0	0	0
9.	*Mariscus alternifolius* Vahl.	Cyperaceae	4.2	2.4	3.8	2.1	7.1	2.8	11.1	4
10.	*Alchornea cordifolia* Schum. & Thonn.	Euphorbiaceae	8.3	9.5	0	0	14.3	8.6	0	0
11.	*Hura crepitans* L.	Euphorbiaceae	12.5	9.5	0	0	0	0	0	0
12.	*Indigofera spicata* L.	Fabaceae	0	0	23.1	25	0	0	0	0
13.	*Sida acuta* Burm.f.	Malvaceae	4.2	2.4	3.8	0	7.1	0	11.1	4
14.	*Ficus benjamina* L.	Moraceae	8.3	2.4	0	0	7.1	2.8	0	0
15.	*Bougainvillea glabra* Schott ex Rohrb	Nyctaginaceae	8.3	14.3	0	0	0	0	0	0
20.	*Paspalum vaginatum* Sw.	Poaceae	8.3	2.4	3.8	6.2	0	8.6	11.1	8
21.	*Cynodan dactylon* (L.) Pers.	Poaceae	4.2	2.4	3.8	0	14.3	14.3	11.1	0
22.	*Zea mays* L.	Poaceae	0	0	0	0	14.3	14.3	11.1	12
23.	Polypodiaceae	Polypodiaceae	4.2	4.7	3.8	2.1	0	0	0	0

***Exp: Experimental *Con: Control**

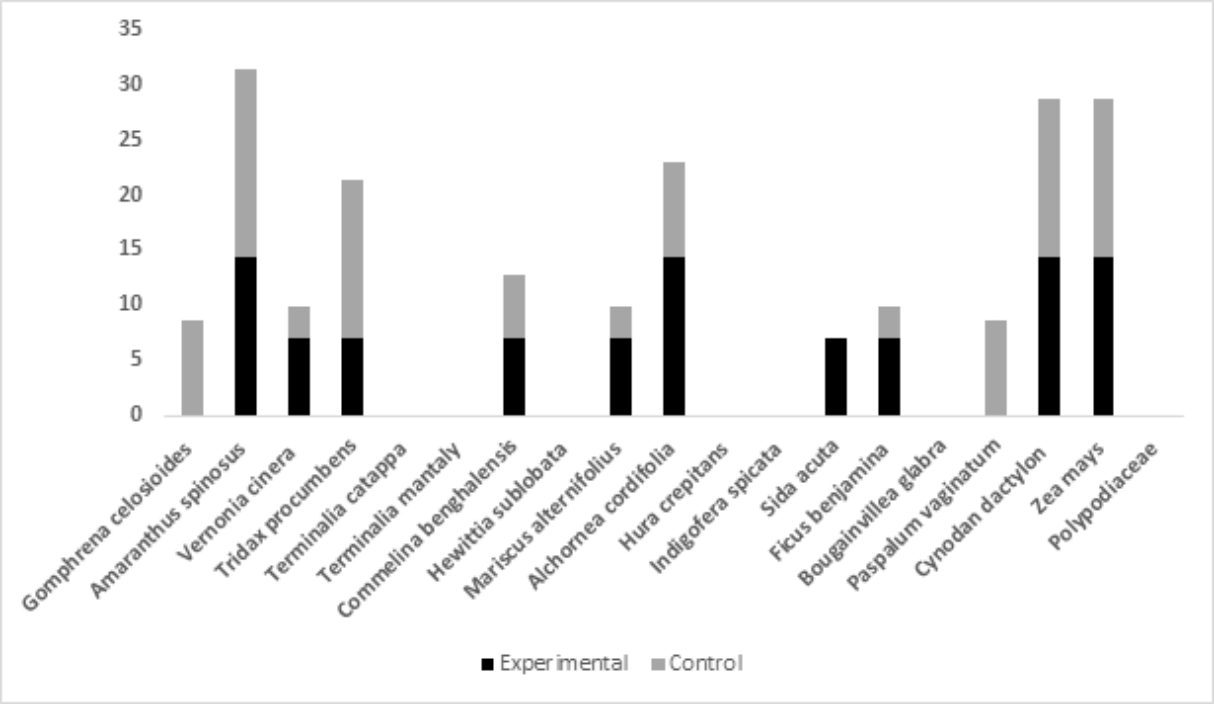

Figure 5: Graphical representation of the recovered palynomorphs in (Akoka 001) criminal case

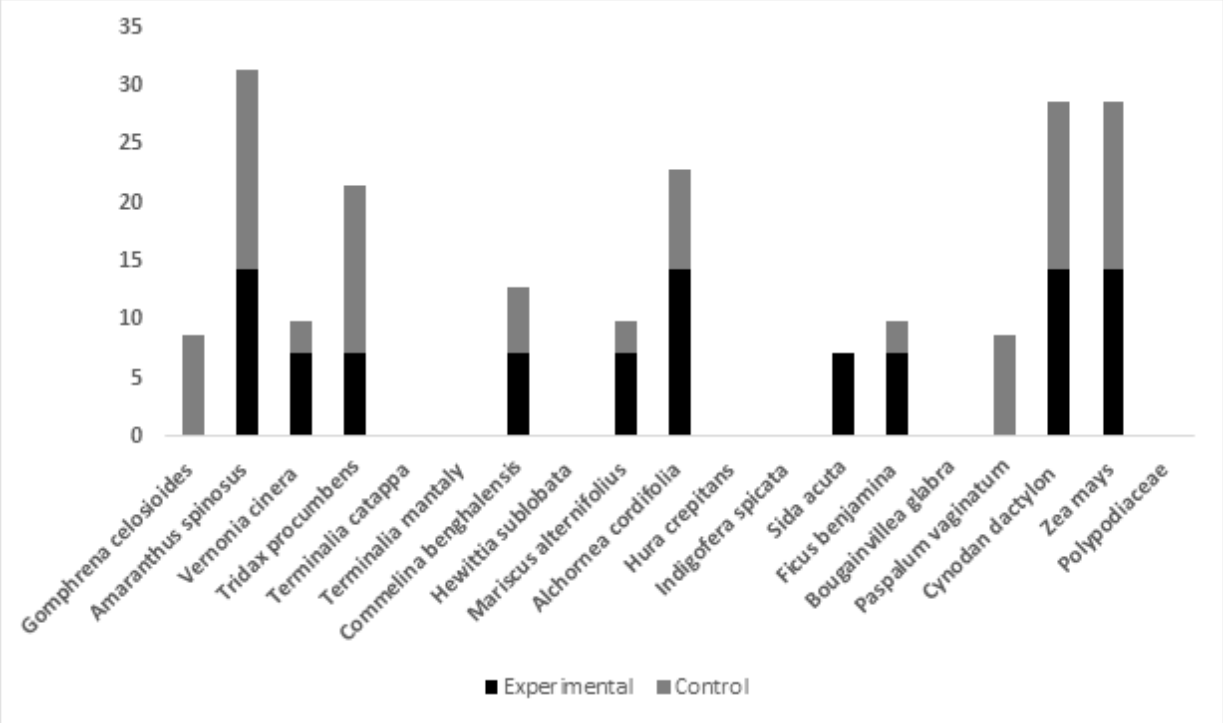

Figure 6: Graphical representation of the recovered palynomorphs in (Akoka 002) criminal case

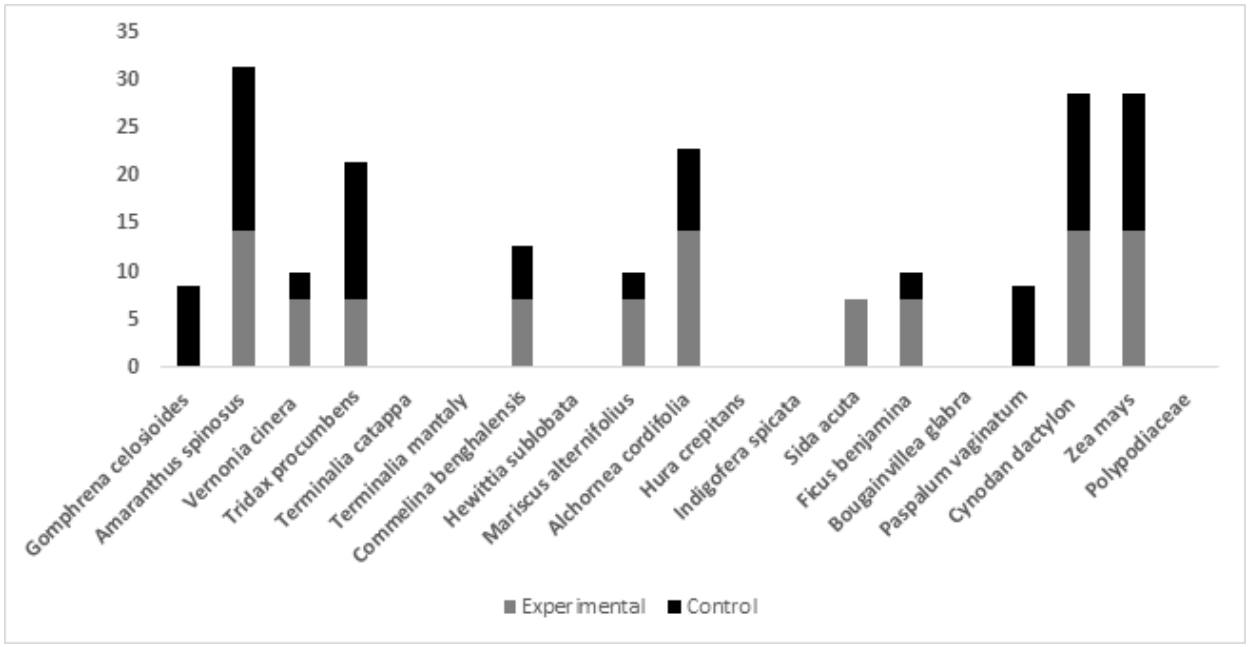

Figure 7: Graphical representation of the recovered palynomorphs in (Akoka 003) criminal case

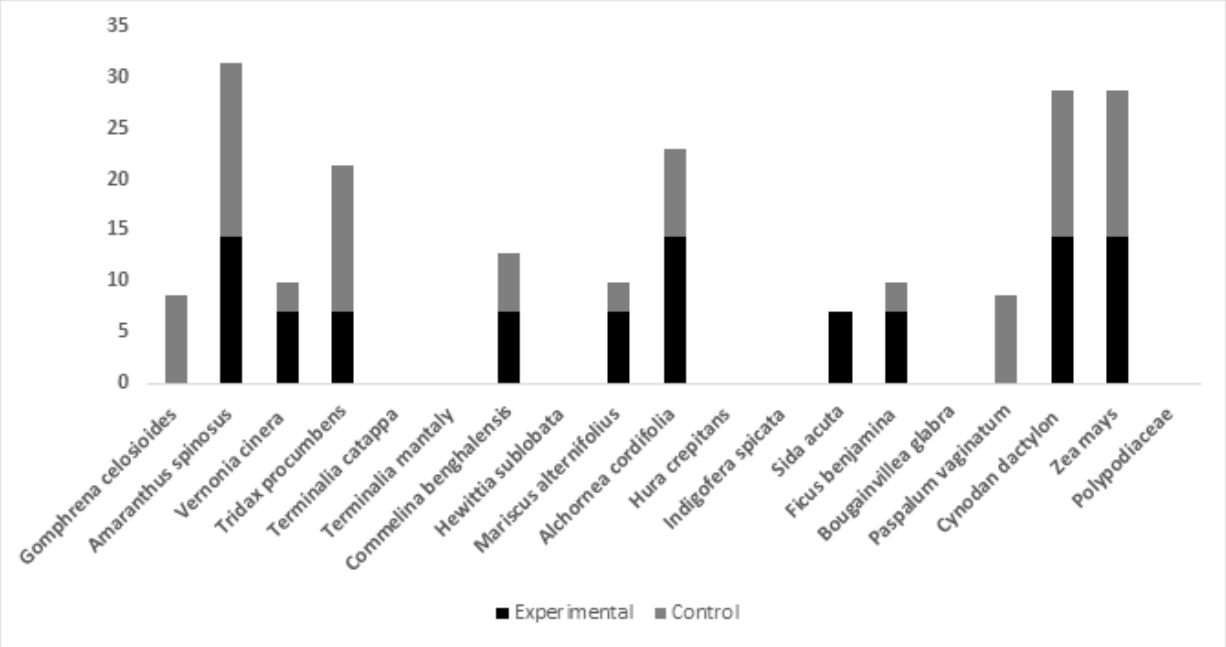

Figure 8: Graphical representation of the recovered palynomorphs in (Akoka 004) criminal c

DISCUSSION

This pollen spectrum showed a close relationship in the diversity of plants in both samples collected from the crime scenes (control) and suspects (sample of interest; experimental). There was a positive correlation between standing vegetation and palynomorphs recovered from both the crime scenes and suspects across the locations. They include *Terminalia mantaly, Hura crepitans, Bougainvillea glabra, Hewittia sublobata, Indigofera spicata, Commelina benghalensis, Tridax procumbens, Amaranthus spinosus, Alchornea cordifolia, Zea mays, Vernonia cinera, Amaranthus spinosus, Gomphrena celosioides* among others.

In Akoka 001 crime scene, samples were retrieved from the vehicle, suspects, and victim (Figure 2). All samples revealed the presence of *Terminalia mantaly, Hura crepitans* and *Bougainvillea glabra* pollen (Figure 1). Also, the parent plants were standing vegetation at Cab Park, supporting the victim's assertion that he and the suspects boarded the same vehicle (cab) on their way to campus. The presence of *Alchornea cordifolia* pollen supported the victim's claims that both suspects were seen hiding at the Guaranty Trust Bank after stealing his phone. Within close vicinity to the Bank, *Alchornea cordifolia* is a dominant plant. Despite the fact that the discovered palynomorphs were able to reveal whether or not the suspects were in the same vehicle (cab) as the victim and their presence in GTB, both suspects denied being in the same vehicle with the victim and stated they picked up the phone on the ground. However, the palynomorphs recovered could not ascertain if the suspects actually stole the phone or picked it on the ground, as attempt to recover pollen directly from the phone proved abortive.

Akoka (002) criminal case: the suspect claimed he was never at the location where the bag was kept. Both experimental (suspect) and control (crime scene) samples were retrieved, and revealed a positive correlation in the number of recovered palynomorphs. During the microscopic examination of samples using a light microscope, clumps of pollen were discovered in *Hewittia sublobata* and *Indigofera spicata,* two of the extant plants located at the crime scene, both of which were flowering at the time when the crime was committed (Figure 3). Mildenhall (2006) identified clumps of pollen found on clothing transferred by direct contact from the flower to an object. It is possible that identifying clumps of the same species of pollen may imply that pollen was physically transferred, not aerially dispersed. This suggests that there might have been direct contact between the suspect and the plant since the plant is not a prolific producer of pollen grains. This implies that the suspect was at the location where

the bag was kept, even though he denied it.

Akoka (003) criminal case: the suspects were accused of abusing hard drugs at an undisclosed area used as a kitchen in an apartment (Figure 4). The alleged denied all allegations. While carrying out forensic examination, remnants of cigarettes and marijuana were found at the scene of the crime. The surroundings of the apartment were used for subsistence farming. In order to ascertain if the suspect was at the crime scene, samples were retrieved from the crime scene as well as from the suspect. Pollen of *Amaranthus spinosus, Zea mays, Alchornea cordifolia, Tridax procumbens,* and *Cynodan dactylon* were recovered from both samples retrieved. There was a positive correlation between the numbers of recovered palynomorphs and the standing vegetation at the scene of the crime. The palynomorphs retrieved are an indication that the practice of subsistence farming was in place as the recovered pollen and spore were mostly cultivars and open vegetation. This indicates that the suspect was at the crime scene.

Akoka (004) criminal case: the suspect was accused of breaking into a room (F 203) in Njokwu Hall of residence to steal an iPhone 6 and a laptop at about 11 pm. The victim said the suspect was seen at intervals peeping into their rooms at odd times. The suspect debunked the claim as false. The stolen item was not found in his possession. A forensic examination was conducted at the crime scene and both pieces of evidence retrieved (crime scene and suspect) were analyzed. Pollen of *Zea mays, Tridax procumbens, Vernonia cinera, Amaranthus spinosus, Gomphrena celosioides,* and *Paspalum vaginatum* were recovered from both samples. The parent plants of the recovered palynomorphs are mostly cultivars and open vegetation due to disturbances by man on the environment. This shows that the suspects came into the hall of residences through the back gate and not through the new hall main entrance as this location is being used as farmlands. Although there was a positive correlation between the suspect and the hall of residences, a negative correlation was observed between the suspect and the crime scene.

CONCLUSION

The present study supports the assertions made by (Walter *et al.,* 2019), that foot wares, ear lobes, clothes, and nostrils can act as an excellent trap for pollen grains, spores, and other particulates organic matter and thus may be considered for their potential use as a forensic tool in legal cases. This observation does not only prove that shoe, cloth, earlobe and nostrils are good pollen traps, but also demonstrates that it is possible to prove or disprove alibis of suspects from different vegetation zones as each region has a unique pollen print and thus pollen grains from these materials might be useful in crime resolution. Forensic palynology should be used in conjunction with other forms of evidence and allowed for an appropriate amount of evidentiary weight on such evidence (Horrocks and Walsh, 1998).

ACKNOWLEDGMENTS

The financial support received from TETfund, Nigeria for the successful completion of this research is greatly appreciated. A deep sense of gratitude goes to the Nigeria Police Force (Zone II Command) and the Department of Botany, Faculty of Science, and the University of Lagos for creating a platform for this research to be carried out.

CONFLICT OF INTEREST

None of the authors has any potential conflict of interest related to this study.

REFERENCES

Bryant, V.M. and Mildenhall, D.C. 1998. Forensic palynology: a new way to catch crooks; in, Bryant, V.M. and Wrenn, J.W. (eds.), New Developments in Palynolomorph Sampling, Extraction, and Analysis. *American Association of Stratigraphic Palynologists Contributions Series,* 33: 145-155.

Demske, D., Tarasov, E.P. and Nakagawa, T. 2013. Atlas of pollen, spores and further non-pollen palynomorphs recorded in the glacial-interglacial late quaternary sediments of Lake Suigetsu, Central Japan. *Quaternary International,* 290(164):

238.

Erdtman, G. 1969. Handbook of Palynology: morphology-taxonomy-ecology: An Introduction to the study of pollen grains and spores. Hafner Publishing Co: New York. 486pp.

Gelorini, V., Verbeken, A., van Geel, B., Cocquyt, C. and Verschuren, D. 2011. Modern non-pollen palynomorphs from East African lake sediments. *Review of Palaeobotany and Palynology*, 164: 143–173.

Gosling, W.D., Miller, C.S. and Livingstone, D.A. 2013. Atlas of the tropical West African pollen flora. *Review of Palaeobotany and Palynology*, 199: 1–135.

Horrocks, M. and Walsh, K.A.J. 1998. Forensic palynology: assessing the value of the evidence. *Review of Palaeobotany and Palynology,* 103: 69-74.

Horrocks, M. and Walsh, K.A.J. 1999. Fine resolution of pollen patterns in limited space: differentiating a crime scene and alibi scene seven metres apart. *Journal of Forensic Science,* 44(2): 417-420.

Horrocks, M. and Walsh, K.A.J. 2001. Pollen on grass clippings: putting the suspect at the scene of the crime. *Journal of Forensic Science,* 46(4): 947-949.

Hutchinson, J.B. and Dalziel, J.M. 1954. Flora of West Tropical Africa. In: Keay RWJ (Ed). Crown Agents for Oversea Governments and Administration, London.

Keay, R.W.J. 1959. An Outline of Nigerian Vegetation. Government Printer (2nd ed), Lagos, Nigeria. 1-46pp.

Keay, R.W.J., Onochie, C.F.A. and Standfield, D. P. 1964. Nigerian trees. Department of Forest Research (Vol. 1), Ibadan, Nigeria.

Mildenhall, D.C. 1990. Forensic palynology in New Zealand. *Review of Palaeobotany and Palynology,* 64: 227-234.

Mildenhall, D.C. 1998. A grain of evidence: invisible pollen grains can be enough to sort out the guilty and the innocent. N*ew Zealand Science Monthly*, 2-8.

Mildenhall, D.C. 2006. An unusual appearance of a common pollen type indicates the scene of the crime. *Forensic Science International,* 163: 236-240.

Mildenhall, D.C., Wiltshire, P.E.J. and Bryant, V.M. 2006. Forensic palynology: why do it and how it works. *Forensic Science International,* 163: 163-172.

Miller-Coyle, H., Ladd, C., Palmbach, T. and Lee, H.C. 2001. The green revolution: botanical contributions to forensics and drug enforcement. *Croatian Medical Journal,* 42(3): 340-345.

Milne, L.A., Bryant, V.M., and Mildenhall, D.C. 2005. Forensic Palynology. In "Forensic Botany: Principles and Applications to Criminal Casework" (Ed. H. Miller Coyle), CRC Publishing: Florida. 217-253pp.

Moore, P.D. and Webb, J.A. 1978. An illustrated guide to pollen analysis. Hodder and Stoughton: United Kingdom. 22-31pp.

Riding, J.B., Rawlins, B.G. and Coley, K.H. 2007. Changes in soil pollen assemblages on footwear worn at different sites. *Palynology,* 31: 135-151.

Walter, O.J., Adekanmbi O.H. and Olowokudejo, J.D. 2019. Palynological and Lithological Investigation of Forensic Materials at the University of Lagos, Nigeria: First Experimental Palynological Approach in Nigeria. *Journal of Forensic Science and Criminology*, 7(1): 104.

Wiltshire, P.E.J. 2006. Hair as a source of forensic evidence in murder investigations. *Forensic Science International,* 163: 241-248.