INVESTIGATING THE ROLE OF POLLEN IN CRIME TRACKING

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ABSTRACT

Forensic experts rely on many basic scientific principles to detect various crimes. One of these sciences is forensic botany, which is concerned with plant life in order to obtain information about crimes. Either from leaves, seeds, or pollen. In this research, we will address palynology as reliable evidence that contributes to the detection of crime the research will provide a comprehensive review of the definition of pollen science and forensic pollen science as some of the most important and strongest evidence that applies scientific methods and techniques in the investigation of crime. Introducing pollen grains from a biological, structural, and morphological point of view. This study also looks at how pollen grains can be collected from different surfaces and how to look at them. Despite the role of pollen science as a powerful and effective guide in legal cases to solve criminal cases by proving or refuting relationships between people and crime scenes, it remains rarely used throughout the world. For a number of reasons, including the lack of information available about this technique and the very limited number of professionals trained to do forensic pollen examination work, there has been very limited attempt to use pollen evidence in criminal or civil cases. So in this paper recommended to pay attention to this vital and important aspect of pure science, which clearly serves to reveal the ambiguity of accidents or explain some unclear scenes by establishing academic and professional programs to deal with pollen professionally and to benefit from the outputs of those programs in various matters, forensic palynology being one of them.

KEYWORDS: *Pollen grain- forensic palynology- forensic botany- crime*

INTRODUCTION

Paleontology Developed by [1] examines the shape and structure of pollen grainwall, It is also known as the science that studies the pods of pollen and germs and not their living contents [2], and the researcher can get good information from it from simple materials and in a short time [3] This science was also defined as the fixed and continuous characteristics carved on the outer wall of the pollen grain, through which we can discern the origin of the genera and plant species [4]. From the above, we conclude that pollen science is concerned with the study of pollen grains everything related to it in terms of form and function. The study of pollen is of great importance to science as genetics and geology and evolutionary sciences and taxonomy Used to clarify ambiguous information using taxonomic classification, phenotypic traits are considered [5]. Pollen grain is used in forensic applications because it is characterized by exceptional stability and resistance to chemical and physical changes, and it has the ability to remain at the crime scene for a long time after the occurrence of the event, preserving its formal and structural properties, no matter how frequently it is transported or circulated within the environment of exchange of materials such as clay and soil with particles of body remains. At the crime scene [6].

Botanical evidence can be useful in determining whether death was caused by accident, suicide, or murder, in addition to the determining the year in which a body was buried. The evidentiary plant can also be used as evidence to determine whether a crime scene is a primary or secondary scene, and pollen can be used as evidence to identify unidentified bodies [7]. Most plant evidence may deteriorate, dry out, be affected by mold, or deform, except for the pollen that was first discovered [7]. Because every piece of criminal evidence has flaws, the use of pollen has some drawbacks, such as the lack of complete information and techniques for collecting samples needed to conduct investigations. Specialists in this field are also very limited [8]; [9].

The use of pollen as a powerful tool to solve crimes has become popular because of its advantages, which outweigh the disadvantages due to the mechanism of its spread. The structure of pollen is also resistant to any external influences such as high or low temperature, humidity, and chemical pollution, and pollen grains remain in their structure for many years [8]. One of its most important characteristics is the distinctive external shape with ornaments and formations engraved on the surface of the pollen, which are stable and distinctive, which is an indication for identifying the classification of a plant that may be associated with a specific environmental habitat or landscape [10]. Pollen has become more reliable as a unique tool for solving crime because its advantages outweigh its disadvantages because of its characteristics, such as its small size, its mechanism of presence and spread, as well as the viscosity of its surfaces, which facilitates its connection with surrounding objects such as different surfaces, skin, and folds of clothing, and the external structure. Pollen and spores are highly resistant to any external environmental conditions, as they are more tolerant of heat and cold, washing, and decomposition. Pollen may remain preserved for many years [8]. Its advantage is also that it can help to know the plants that they track and thus determine the geographical location of the sample, establish links between crime scenes and individuals, test samples, and determine whether someone is in possession of or trading in prohibited substances [11]; [12]. Also, pollen sticks to fabrics and small gaps in shoes and other things, and it is not possible to get rid of germs and pollen effectively. Rather, it is held in motion because of the formation of its surface and the static charges in it and does not fall from clothes and shoes that are exposed to washing in the washing machine [13]. This makes them very valuable as evidence of sites or surfaces [14].

The first attempt to use pollen to solve a murder case in 1959 as archaeological evidence is considered the date of adoption of the use of pollen science as a source of forensic evidence [6], and since then pollen analysis has been used to solve crimes such as murder [15], genocide [16], counterfeiting [17], drug smuggling [18], and rape [19], and pollen varies widely even at the species level ,therefore, it is seasonal and closely related to its geographical location, and therefore its presence can indicate a particular season, and sometimes the geographical location in which a crime was committed [20]. The use of pollen in forensic evidence is based on the assumption that different regions of the world have a distinct set of pollen species, and this evidence can be used to link crime scenes to suspects. Ochando et al. [21] The importance of using pollen science in forensic studies in order to determine the source of the sample and the ability to link people or objects to the crime scene was demonstrated, through samples obtained in three different locations in semi-arid southeastern Spain from four surfaces (directly from soil, then from fabric samples that were in direct contact with the ground, another set of clothing collected using an adhesive, and the final from sediment accumulating on shoes). All pollen samples were consistent with relevant information about the vegetation cover of each site, despite its importance and potential in the forensic investigation, but this science is still largely underutilized in the criminal field due to the scarcity of skilled poll enologists who specialize in forensics cases and the tedious nature of the analysis. These challenges are overcome by using more sophisticated analytical methodologies such as Raman spectroscopy, stable isotope analysis, and DNA metabolism [22].

The biological composition of pollen

Pollen grains are the male gametes of the flower, which are found before the flower's maturity in the anther sac inside the pollen. At the beginning of the fertilization process, pollen grains are characterized by containing two nuclei: a vegetative nucleus (the tubular nucleus) and a reproductive nucleus, which in turn divides into two male nuclei, one of which fuses with the nucleus of ovule' nucleus to form the zygote, and the other fuses with the primary endosperm nucleus to form the endosperm nucleus in what is known as the double fertilization characteristic of angiosperms. Each pollen grain contains

half the number of chromosomes in the original cell [23], so it is known to be haploid [24]. The subtle structural details of pollen grains, such as their size, number, shape, thickness, layers, and surrounding wall, are the main distinguishing features between different genera and species of the same genus.

The physical properties of pollen

To the naked eye, it appears that the pollen is a homogeneous mass of fine yellow dust. When examined under a microscope, it turns out that this mass is actually made up of thousands of individual pollen grains that are unique to the plant species that produced them, despite their microscopic size. Pollen grains come in a wide range of shapes and sizes, many of which have exceptionally intricate surface ornamental patterns. It is this variety of physical features that enables paleontologists to identify pollen and spores as coming from a unique plant family and a particular plant genus or species. Paleontologists have called pollen and spores "plant fingerprints" [25], a scanning electron microscope is used when higher magnifications of fine surface details are required to distinguish subtle differences between pollen grains of different plant species.

Pollen size

Pollen and spores' range in size from 5 to 200 micrometers in diameter, but most fall within the 20- 70µm size range. There are 1,000µm in 1mm. Size is a feature that helps us place a pollen species into a general taxa (genus); however, the potential for size changes within a genus makes this trait not accurate for identifying pollen at the plant species level.

Pollen shape

Pollen comes in many forms. They may be spherical, triangular, elliptical, hexagonal, pentagonal, or display any number of variations at the basic level. For example, a pollen grain may be triangular in shape with a convex shape, triangular in a concave shape, or triangular in shape with bumps on the top or sides. There are differences in the ratio of polar and equatorial dimensions, so that some grains are thinner in one plane than the other. The shape is useful to help place a pollen species in a particular category, but the shape alone is usually not sufficient to obtain a plant species identification. Pollen varies in shape: spherical, oval, rectangle, triangular, quadrangular, pentagonal, with deep depressions, and with arms. [24]. Most pollen grains also have small openings through which male gametes exit during the pollination process. Also, some types of pollen do not have germination openings and instead have thin walls that rupture to allow the male gametes to exit. The openings range from a single circular hole like a pore to a wide variety of pores. In general, the type of pore hole is broadly consistent within many other plant families, but more often at the level of other genus and species.

Outer sculpture

Pollen carving refers to the decoration on the surface of pollen grains. The decoration may be very simple or very complex, but it is the same for pollen from plants of the same species. Sculpting forms according to the depressions and heights of the structures arranged on the surface or the protrusions protruding from them for example, some notable forms of decoration are called granules (very small sand-like bumps), thorns (thorns), warts (wart-shaped hemispherical bodies), rods (stick-like), or reticulate (a mesh resembling a beehive). Some pollen grains, such as those found in grasses, have surfaces that appear almost smooth when examined under a light microscope but have distinct surface patterns when viewed with an electron microscope under high magnification and resolution [26].

Wall formation and preserve it

Regarding the composition of the pollen grain, Saad [23] explained that the wall of the mature pollen grain consists of two layers: the outer wall, called Exine, which consists of two layers, an inner layer called Endine and consisting of cellulose and pectin, and an outer layer, called Sexin, which consists of a very hard substance called Sporopollenin. It is one of the hardest organic materials in existence and one of the most resistant plant materials to weather and chemical factors, and to it is attributed the survival of pollen between the rocks unaffected, preserving its different shape and composition. As it is slow in decomposing and pollen can be retrieved from rocks that are millions of years old, it is a valuable asset for oil companies and archaeologists. Because they are microscopic, they remain invisible and are considered a silent witness [27]. The function of the outer wall is to protect the contents of the pollen from drying out and external influences. The thinness of this layer is noted above the germination holes to allow the germination tube to exit. The inner wall is a thin cellulosic layer that completely surrounds the protoplasm.

Pollen distribution mechanism

Pollen can be transferred from the male organs to the female organs in flowers (the process of pollination) by several means, including the wind, which throws pollen grains randomly from the male organs (stamens) to the female organs (stigmas). Because pollination by the wind is a random process, wind-pollinated plants produce large amounts of pollen. For example, the male cannabis flower may produce between 60 and 80,000 pollen grains, while the "Durr" tree, which consists of many flowers, produces between 4-6 million pollen grains. Pollen and fungal spores carried by the wind are the reason why thousands of people with allergies suffer every year [28].

Pollen collection

Soil related to crime is considered to be of all kinds, whether dry or wet, one of the excellent samples from which pollen can be extracted, and it can be removed from clothes, human skin, shoes, suspect cars, or the victim in the following ways:

1. To lift samples of wet or dry dirt and mud contamination from objects

Many types of forensic samples, such as soil, clothing, and illegal drugs, usually contain different forms of pollen, so these samples must be chemically treated to collect the consistent forms of pollen they contain. It comprises acetic anhydride mixed with a concentrated compound of sulfuric acid in a ratio of 9:1. The tubes are placed in a boiling water bath for 3–5 minutes, followed by centrifugation, and the supernatant is discarded. The precipitate is washed with water, and excess water is discarded. It is transferred to a glass slide with drops of glycerol for examination under a light microscope at a power of 40x–100x, and the size of the different pollen grains is determined and calculated [29].

The classification of pollen and spores is usually known by professionals, at least 100–200 of the collected figures are calculated manually for each sample; the pollen size is calculated, and the ratio between the lengths of the grain (equatorial diameter and polar length) is calculated; then graphs and illustrations are noted; then samples are compared to other known samples, and the types and amounts of pollen from each sample are usually compared between samples. At this point, pollen scientists in forensic labs often use their knowledge and experience to figure out what the data means [30].

2. Pollen grain extraction from woven materials

Cloth, clothing, coverings such as blankets and carpets, and all materials that contain fibers, such as fur coats, have a characteristic similar to human hair in that pollen grains are trapped between their fibers. In addition, plant pollen in the air may fall on the offender's clothing and be trapped between its fibers or on the exposed surface of the clothing. Here the textiles are collected as samples to extract pollen from them by collecting the entire woven material and keeping it in large sterile plastic bags that are closed tightly and guarded. If the woven materials are large and cannot be lifted completely, then transparent adhesive cellophane tapes are used, where several samples are taken from the woven materials. After that, the grains are extracted by rinsing the entire woven material in a solution of distilled water and warm soap to release the pollen grains that are trapped between the fibers in the rinse solution. [4]. Chun-Liang et al. [31] developed a simple method for collecting pollen from clothing. Using the adhesive tape method is simpler, faster, and less expensive than other methods. It is known that pollen and spores in general are released in large quantities, depending on the mechanism of dispersal and proximity between plants of the same species. So, if there is a lot of similar pollen on or in something like soil, it can be transferred to other things, like the shoes or clot hes of the suspects, in large numbers, making it more likely that experts will be able to find them [8].

3. Pollen extraction from dust

If the amount of dust is sufficient, it is lifted by sweeping it into special containers; if the amount of dust is small, it is lifted by adhesive tapes of transparent cellophane, and the width of each strip is about an inch. This is done by placing the adhesive tape on the surface that has traces of dust and, while wearing gloves, carefully removing the tape. We notice that the dust has stuck to the adhesive tape. After that, the two ends of the tape are attached to each other by applying one half of the tape to the other half, and in this way, we protect the sample and ensure that it is not contaminated with other pollen grains [32].

In order to ensure the safety of the sample raised by the adhesive tape, the adhesive tapes on which the samples are located are placed in plastic bags that are opened and closed with a gutter, and each tape is placed separately. A sufficient number of strips must be collected to ensure that extractions are performed without problems for the sample. When examining the samples in the laboratory, the dust stuck in the adhesive tape is separated using special solvents.

4. Extracting pollen from packaging materials

Samples are lifted from these materials using a small portable vacuum cleaner, as this method is effective and fast, as the criminal investigator can extract grains from large areas, and the suction force releases most of the trapped grains and enters them into the inner bag of the broom. In addition, grains can be sucked from the inner linings of containers, especially the sides of cardboard or wooden boxes. It must be taken into account that the inner bag of the broom is free of any contamination, i.e., clean and sterile, and after each use, the broom must be completely cleaned. It is possible to use vacuum bags made of linen, fiberglass, or filter paper, as these materials are suitable for the pollen extraction process. These materials can also be fully chemically treated in the forensic laboratory to extract the grains from them by dissolving them in some acids that do not affect the pollen grains [32].

5. Extracting pollen from drugs

The detection of drug sources is an important aspect of pollen screening technology, which can identify drug packaging and packaging locations. Since the cannabis plant, for example, is often grown and harvested, it is packaged and packaged in open areas, so very abundant quantities of pollen grains in the area in which these operations take place will merge with the packaged hashish. But if the cannabis is grown, harvested, and processed indoors, very few pollen grains from that particular area will merge, and sometimes none of those grains will merge with the packaged cannabis, which makes the exact geographical area in which the cannabis has been processed extremely important [32]. Likewise, the manufacture of cocaine begins with collecting the leaves of the coca plant, then it is dried and treated in the air in open areas, and then cocaine is extracted. Because most of these processes occur near the coca plant's growing areas or directly on farms, pollen from other plants in that area will be combined with pure cocaine. In the manufacture of heroin, the first step is to scratch the outer surface of the unripe fruit of the poppy plant, and as a result of scratching the plant, sap comes out, which helps in trapping the pollen. This can also happen when the psychoactive cannabis resin is taken from the tops of the plants [33].

Pollen examination

Pollen must be in a pure state in order to be properly examined. Samples containing pollen are usually kept in a cooler at -20°C. Several experiments must be conducted to purify pollen from suspended matter such as resins and waxes using distilled water and ethanol. According to the procedure of D'Albore [34]. for a whole day or several days, a mixture of ethanol, chloroform, and acetone (1:1:1) may be used. The suspension is divided into two centrifugal tubes and a centrifuge, and the precipitate is resuspended by adding 13 ml of ethanol; each tube is then centrifuged, and I add 12 ml of 10% KOH to each tube and leave it to boil for two minutes in a water bath [35], the examination is carried out first under a light microscope, followed by the use of electron microscopes to obtain magnification forces that show the parts of pollen that distinguish them. Depending on where the plant samples (pollen) came from, there are different ways to purify them.

Application of pollen to forensic science

Bock and Norris [36] mentioned the areas of use of pollen in forensic science as follows:

- To prove the suspect's relationship to the crime scene or the location where the crime was discovered.
- To prove that the evidence was found at the crime scene or the location where the crime was discovered, relating to the suspect.
- To prove that the evidence found at the location where the crime was discovered is related to the crime scene.
- To prove or deny the allegations of the suspects. determining and limiting the list of suspects
- To determine the chronological age of evidence, including food and drugs.
- Useful in providing information about the environment from which the guide came.
- Useful in providing information on the geographical source of the guide.
- Determine the season in which the incident occurred.
- Assist investigators in the investigation of suspects.
- Contribute to locating secret tombs' human remains.
- Determine what happens at the time of the victim's death.
- Determine the period in which the human remains were buried.

Reasons for the rare use of pollen data in crime detection

Bryant and Jones [9] Pointed out the limited use of pollen data in criminal investigations in America and relied on a number of reasons for this, including that the method of collecting samples must be professional in order to avoid contamination of those samples and the ignorance of the science of spores and pollen among the investigators. And lawyers and judges may also be a compelling reason. There is also a shortage of specialists in the science of spores and pollen and in training those who wish to conduct studies in the science of spores and forensic pollen. He also mentioned that there is no university or other facility for forensic spores and pollen in the United States, in addition to the lack of available reference materials for pollen identification. Some of the reasons given are clear and convincing, but that doesn't mean we can't find and solve the problems mentioned and keep working to improve this important part of science and use it to solve problems and find criminals.

CONCLUSION

The pollen examination technique is one of the important techniques in the criminal field that can be practically applied to samples that have been seized from pollen, whether those samples are dirt, dust, clay, or in containers, in order to obtain technical evidence linking the place of the crime. And the suspect or the places where the bodies were discovered and the perpetrator was convicted, because of its characteristics that make it silent and strong evidence, as it cannot be seen with the naked eye, sticks to the surrounding surfaces, and cannot be removed even after washing, and because its results are reliable, it should be sought to prepare trained experts and the availability of this technique in all forensic laboratories, which can thus provide the best results at the lowest costs. This research has clarified the importance of pollen technology in tracking the traces of crimes and linking the suspect with the crime scene, as well as identifying and discovering geographical locations and any seasons of the year in which the crime occurred, knowing the sources of counterfeit medicines, and determining the primary places for burial of bodies if they were transferred from one location to another, in addition to mass graves. Despite the importance of pollen, its use as a technical guide in forensic science is still limited and may be unknown in some countries. There are a few countries that apply this technology and resort to it in the absence of evidence, and New Zealand is one of the first countries that became interested in this technology and developed methods. Extracting pollen and examining it in samples related to crimes will thus prompt the world to use it as technical evidence accepted by the courts in the field of criminal investigations to prove the charge and convict the accused. Therefore, we recommend that educational authorities and government training platforms pay attention to this technology to train and prepare trained and capable human cadres to work professionally in the field of documenting forensic evidence and defining it fully and acceptingly in various criminal cases. And conducting more scientific studies and research in this field to spread full awareness of the importance and role of pollen screening technology and use it as a proven guide to provide information that explains questions related to issues and uncovers their ambiguities.

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