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RESEARCH ARTICLE

USE OF POLLEN FINGERPRINTS AS A TOOL IN FORENSIC SCIENCE

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ABSTRACT

Palynology, the science of pollen, spores, algal cysts and other microscopic plant bodies is a multi-disciplinary field with applications in botany, zoology, entomology, immunology, forensic science, geology, archaeology, geography and environmental sciences. Pollen and spores collectively called palynomorphs can serve as valuable forensic tools. Their utility lies in their abundance; different dispersal mechanisms; resistance to mechanical, chemical and biological destruction; microscopic size and specific morphology. Pollen groups charactering different environment and scenes can easily be picked up and transported. Their often morphology allows identification of parent plant which can be related to a specific ecological habitat or a specific scene. Pollens are expected to be omnipresent may it be a fossil, rock, soil and dirt, hair, fur, woven material, packaging material, air filter, drugs, honey, dried fruit, tobacco, tea, stomach and intestine or excreta. As cited in literature, the forensic use of pollen and spores i.e. forensic palynolgy can be applied to cases of forgery, production and distribution of illegal drugs, assaults, robbery, theft, rapes, homicide, genocide, terrorism, arson, hit and run crimes, counterfeiting of currency, fake antiques, removal of artifacts from historic and archeological sites, illegal poaching of animals and cases involving illegal pollution of the environment. Despite being an effective tool, the full potential of forensic palynolgy remains unutilised and ignored in most countries including India.

INTRODUCTION

Forensic palynology is the study of pollen and other palynomorphs for evidence from a crime scene. The science of forensic palynology traditionally focuses on legal evidence derived from the study of pollen and spores, both fossil and modern. In the broader prospective, the field of forensic palynology also includes legal information derived from the analyses of other palynomorphs such as dinoflagellates, acritarchs, and chitinozoans (Faegri *et al.*, 1989). Because of their microscopic entity, pollens are different type of trace evidence found at the scene of crime. In almost every case pollens are expected to be present, be it in wearing apparels, shoes; body parts especially in hairs, etc. Pain (1993) mentioned that pollen and spores are abundant in the soil, dirt and dust samples. Pollen grains disperse by different media such as air, animals including man, insects such as bees, butterfly etc. Pollen grains can be differentiated by their external morphology. Their variable shape, size, aperture, and exine characteristics help in their identification. The exine of the pollen is resistant to acetolysis, physical and biological degradation. Due to this property of exine, pollen grains can be found well preserved at a crime scene for a long period. One of the earliest reported cases (1959) solved using palynology was from Sweden where a woman was killed during a trip.

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Palynological examination was done to determine the time and place of her murder. The examination suggested that the lady was murdered elsewhere and body was transferred later on because the dirt lacked pollen from plants common in the area where the body was found. Mud found on that vehicle and shoes can be linked with crime. The pollen evidence can be useful in linking a specific crime with a specific geographical area (Brown and Llewellyn, 1991). Mildenhall (1992) reported a case of murder after kidnapping and sexual assault in which pollen grains from the woman's clothes matched the pollen from the suspect's clothing. Horrocks and Walsh (1998, 1999) reported the importance of pollen as evidence in court. To support his findings, he presented palynological data in three cases of alleged rape and death. According to Horrocks *et al*. (1998) the soil samples are very helpful for palynological analysis in forensics because the pollen samples within a localized area are similar and are different from other localized areas. Stanley (1992) has reported a case from Central Texas where authorities seized a supply of marijuana. This case was also solved using pollen analysis. According to Weatherford (1987), the Cocoa leaves turn into Cocaine when dried in the open and processed outdoor. Pollen fingerprints can be very useful in determining the source of the cocaine samples. Pollen of a plant, *Serjania lethalis* (Sapinadaceae), found in the stomach and excreta provided a clue to several deaths in Brazil who died after consuming poisonous honey. As reported by Palenik (1982) during the 1960s and 1970s, Swiss criminalist

Max Frei often used pollen as forensic evidence to link suspects to crime scenes. In a case, the pistol used in a murder was used as evidence based on pollen present on it. According to Pearson (1991) the importance of forensic pollen fingerprints has been highlighted very prominently in a murder mystery called The Probable Cause. Review of literature indicates that forensic palynology has not made much headway in India. In this paper an attempt has been made to highlight the significance of pollens in solving forensic problems.

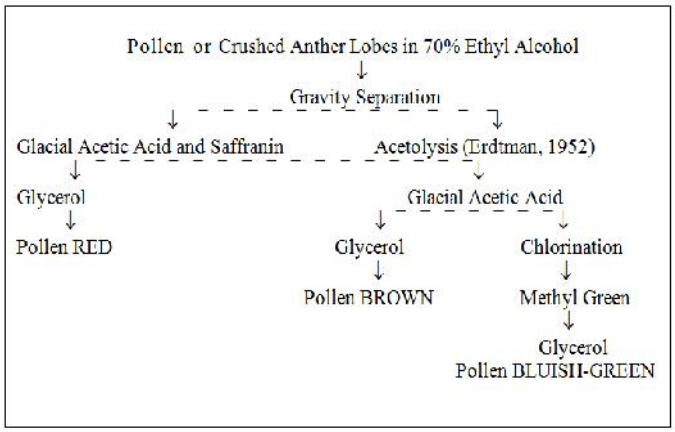
Why is pollen a good forensic tool?

1. Many plants produce large amount of pollen which are carried by air currents and eventually fall to the ground to form a thin layer. Every geographical location has a unique '*pollen print*' which can help in linking things to the exact location.
2. Pollen is minute in size, invisible to the naked eye, and gets trapped on variety of objects. Therefore pollen from plants in any region, pollen from a specific crime scene can become evidence without being noticed by suspects or criminals.
3. Every species produces unique pollen which can be identified as coming from the parent plant. However, often the pollen of closely related species or even related genera may appear similar but scanning electron microscope helps in precise identification.
4. Pollen is tough and durable. Its exine is made from one of the most enduring of natural materials, sporopollenin (Faegri and Iversen, 1975), making it able to maintain its shape and character despite adverse environmental conditions (Kearns and Inouye, 1993). For example, pollen buried in soil sediments for thousands of years can still be identified to genus and, therefore, is an extremely useful tool in palaeontology and palaeoanthropology (Erdtman, 1969). This durability also allows the pollen grain to be identifiable after being digested. The pollen and spore evidence from a region or crime scene can remain intact for millions of years. If crime scene evidence is handled with care, the trapped pollen can be recovered and used for forensic investigations even after many years.

POLLEN ANALYSIS METHODOLOGY

Light Microscopy (LM)

Slides are prepared following the steps shown below



Once samples have been prepared chemically, samples are mounted on microscope slides using silicon oil, glycerol or glycerol-jelly and examined using light microscopy. For pollen terminology Erdtman (1952, 1969) is generally followed. Various parameters taken for identification are shape, apertures, colpi and pore diameter, exine thickness and ornamentation range in pollen size, etc.

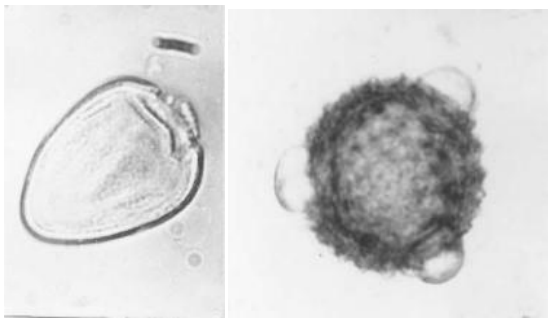


Figure 1. Light microscope micrograph of pollen grains showing morphological details like shape, size, ornamentation, etc.

Some cases from literature

Some of the actual cases where forensic palynology was used successfully to provide vital information in a civil or criminal suit are as follows:

1. As mentioned by Jamiesen and Moenssens (2009), in New Zealand a man robbed a store and escaped on a motorcycle. The pollen trapped in the mud on his shoes was used as an evidence for criminal investigations.
2. As reported by Milne *et al.* (2005), in a murder case from Australia a man killed his girlfriend and then drove her car 50 km to a remote coastal park where he hid her body under some bushes. The pollen from his clothing helped to convict the suspect.
3. In a case from the island of Oahu in Hawaii, a stolen van was used in a bank robbery in Honolulu and then abandoned. Palynological study of the air filter of the van led to the capture of the bank robbers.
4. Wiltshire (2006) reported use for pollen data to solve a murder case in Texas where five women were murdered. Hair samples collected from the bodies of these unidentified women buried in a series of shallow graves were examined for pollen which provided clue in this case.
5. As reported by Bryant and Mildenhall (1998), the pollen from hair of sheep proved critical in conviction of a rustler from New Zealand who stole 300 sheep from a ranch and tried to sell them at a livestock auction.
6. A case of smuggling of cocaine was solved in New York City. A portion was sent to a forensic palynologist for analysis. The pollen recovered from the sample provided clues that cocaine was smuggled from tropical South America (Stanley, 1992).
7. According to Bryant and Midenhall (1998), a European company shipped expensive machinery to Asia. The pollen analysis identified the location of theft.
8. In 1994, a mass grave containing the remains of 32 young males was discovered in Magdeburg, Germany. The pollen studies confirmed that the victims were probably Russian soldiers killed by the Soviet Secret Police in 1953 (Szibor *et al.*, 1998).

Summary and future prospects

The full potential of forensic palynology remains untapped and ignored in most countries including India. New Zealand takes the lead in use of forensic palynology and in acceptance of pollen evidence in courts. However, the absence of published literature on the subject reflects that use of science of forensic palynology is little.Forensic palynology is in its infancy. It remains unutilized in many regions of the world, is under used in other regions, and is not yet recognized as being valuable evidence in most courts. Hopefully, as the benefits of pollen analyses are realized, forensic palynology will become a valuable tool.

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