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Original Review Article

Role of Forensic Botany in Crime Scene Investigation -A literature review

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Abstract

Introduction: Forensic botany, the scientific application of phytology in a criminal or crime scene investigation to provide plant-related trace or gross material that provide substantial support in the investigation. Forensic botany helps to serve justice in many investigations, to serve the justice by the court of law. Even though a small section, forensic botany itself has several specific subgroups, based on its origin. **Objective**: To define a few subdivisions of forensic botany and explore forensic botany based investigation reported in the public domain. **Methodology:** This short literature survey was done using two search engines Google Scholar and Pub Med to collect the articles. We used keywords Forensic Botany, Crime scene investigation, Forensic Evidence, to explore the relevant articles. Only the freely available articles in the English language were considered for the present review. **Result & Discussion:** Present research provides information about plants and their traces that can be used even in forensics. Examples of plants its parts, pollen /spores, bryophytes collected from the crime scene, bodies of suspects or from their belongings can play a crucial role in solving cases. **Conclusion:** The application of forensic botany was one of the crucial tools produce by the investigators in the court of law to serve justice. No doubt there is a lot of scope in forensic botany in the Indian context for future forensic learners and researchers.

1. Introduction

Collection of evidence at any scene of the crime or from the body of the victim recovered is a challenging task. This not only requires skill but also knowledge about various types of evidence present even in a trace form. Geography or local environmental surroundings from where the incident occurred or the body was found left traces there. Forensic Botany is a scientific application of phytology in a criminal or crime scene investigation to provide substantial support to the investigators as well as to the medico-legal personals. It involves a thorough process about the use of plants or the materials that originated from plants to recreate what was happen or where it happened in the investigation of any crime. In addition, many times traces of botanical evidence also helped to link the suspect to the crime scene.[1] Plant remains like wood, twigs, seeds, fruit, leaves, flowers, pollen/ spores can be found almost any-where and can offer a variety of evidence helping the botanists to identify the season when the crime took

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place, its geographical location, whether the body was moved after a murder or how long it has remained buried. Forensic botany has subdivisions like plant taxonomy, plant ecology, palynology, limnology, forensic ecology & dendrochronology.[2]

For a robust crime scene or medico-legal investigations, applied disciplines like forensic botany, forensic entomology helps in interpreting the found evidence. This present study was done to explore the application & importance of forensic botany as a tool for crime scene investigation through a literature survey. Objectives of this study was to define a few subdivisions of forensic botany and explore forensic botany-based investigation reported in the public domain

2. Methodology

By using two search engines Google Scholar and PubMed we investigated the articles and case reports that used forensic botany. We collected the articles using the keywords Forensic Botany, Crime scene investigation, Forensic Evidence. Freely available articles in the English language were thoroughly studied and then concise for the present review. Even though this is a short literature survey it provides substantial support for the application of forensic botany in forensic investigations and in Medico-Legal investigations. In India, it is not as popular as in western countries but still few cases were solved on that ground. The paper provides an opportunity for future researchers to explore more in this area and develop the domain that can assist to serve justice.

3. Results & discussion

Findings from the literature survey showed that there is a variety of sub-discipline that one has to know in forensic botany. We found several cases related to these sub-disciplines which were used in crime scene investigation, a few of them are presented below-

3.1 Forensic Dendrochronology:

As its name reflects (dendrons =growth rings of trees, chronos = time, ology = the study of)[i] it is the study of the plants and their growth ring in the stems with the time. This knowledge helps in determination of time since death of the body in a comparative manner. Estimating the number of growth rings in the stem of various trees helps in determining the time of advanced decomposed staged corpses. In 1935, dendrochronology was used as the first botanical testimony by Dr. Arthur Koehler, a wood expert. He was asked to testify against accused (Bruno Hauptmann) for kidnapping and murder of 18-month-old son of famous aviator Charles Lindbergh in the court of law. Dr. Arthur matched the wood of the ladder collected from the crime scene with the wood in the attic of Mr. Hauptmann, which was an important clue that was produced as evidence in that particular case. This was the first reported case and introduced application of botany in forensics and was accepted as evidence in justice system.[1]

In 2011, in Italy, skeletal remains of a woman who was reported missing were found in a bush by some maintenance workers. The floral materials found on the skeletal remains and the surrounding vegetation was collected carefully and examined. Based on the botanical evidence her husband was arrested on charges of murder and unlawful disposal of the body.[3] An example of botanical elements found inside and outside of a skull that was recovered from jungle is depicted in **fig 1.**

Fig 1: Human skull showing plant materials inside the mouth and root fragments in the eye orbit (Photo Courtesy Dr Nasir).

In Indian scenario Patil et al., (2018) identified the weed material of Xanthium Strumarium L in the case of 5-year-old victim of rape and the accused collected from their clothes and crime scene using maceration and Energy Dispersive X-ray Fluorescence (ED-XRF) methods.[3] Caccianiga *et al.,* (2020) reported a case in their published work about a case where a piece of wooden stick that was collected from the crime

scene; and another wooden stick that was used as a weapon and seized from the accused, both belonged to the same plant material and provided the link between the criminal, the victim and the scene of occurrence.[4]

3.2 Palynology:

This study involves the type, pattern, shape and characteristics of pollens to identify its plant species and other botanical characteristics of the specific plant. Based on the trace evidences, such as pollen, at scene of crime helps the investigator in further investigations to solve the crime.

New Zealand is the first country to use pollen as evidence in solving civil & criminal matters. Presence of pollen helped in revealing the truth that hundreds were killed and buried in seven graves in Srebrenica in July 1995.[5]

A case of forged documents was solved from the presence of cedar pollen which is seen in autumn in the ink used to sign the document, which was dated June. Similarly in a case of rape reported in New Zealand the victim identified the suspect who attacked her but the charges were denied by the person, pollen played important role in catching the culprit as it was found on the clothes of the victim as well as the suspect.[6]

In India, many a times rape cases have not been solved either because of lack of scientific evidences or because of unintentional avoidance to processing of scientific evidences. In many rape cases that occurred in secluded & remote areas, such pollens or botanical evidence if collected and processed properly may provide an important clue to solve the cases. Availability of palynomorphs on clothes, shoes, ropes and other belongings from both victim and accused in such cases may help to identify plant species to co relate the region where it was found and can help in identifying the place where incidence happened.[7]

The murder of 15-year-old young girl in New York in 1979 whose body was recovered from cornfield remained a mystery for John York, a detective by profession. In 2006 he reopened the case using ‘‘criminological dust investigation” for which he collected the garments of the young victim and on careful examination found dust types in her pockets other than found in the cornfield. This led to the revelation and finally identification of the victim in 2015 as Tammy Jo Alexander, who had fled from her home in south Florida.[8]

Research conducted by Hunt and Morawska (2020) showed that apart from clothing’s, wearable’s, footwear etc. Presence of pollen may also be traced from human skin. Pollen presence can be traced even if a person has washed the skin portion twice or thrice.[9] The pollens are seasonal and restricted to certain geographical locations so a complete database of the flowering plants region wise can be an asset in crime scene investigation or for comparison with pollens of surrounding area.[10] The advantage of pollens and spores is that they are microscopic, not visible to naked eye and are highly resistant because of their exine.[11] Even though it is important in forensic investigation there are countries that do not recognize pollen in the court of law. Research and its practical applicability in forensic in India have not gained popularity as it should have, even though its use and importance are found in forensic teachings and research activities.[5]

3.3 Limnology:

The systematic study of aquatic plant life from different water sources is called limnology. This can be applied to death due to drowning wherein botanists identify the number and species of diatoms present in the lungs as well as other tissues and compares it to the scene of crime where the body was found. The seasonal nature of algae and diatoms can help in giving approximate time since death. Both the light and scanning electron microscopy can identify diatoms.[12] A case of brutal attack on two young boys by a group of teenage boys and finally drowning them in a pond was reported in 1991 at Connecticut in southern New England. One of the survivors managed to escape and reported it to the locals. The case could be solved by examining the aquatic microorganisms found in the sneakers of the assailants & its comparison with those found in the pond (crime Scene) which was found to be similar showing the algal communities and 3 prominent species of diatoms present in the pond water.[13]

Vinayak et al., *(*2012) reported the “Shopian Rape & Murder case” at Jammu & Kashmir which involved two female victims whose bodies were recovered from water body. The presence of diatom similar to those found in river declared the case to be that of ante mortem drowning.[14] Researchers reported that diatoms can be recovered from the foot wears even after 168 hours and can be useful for investigation in forensic case scenarios.[15]

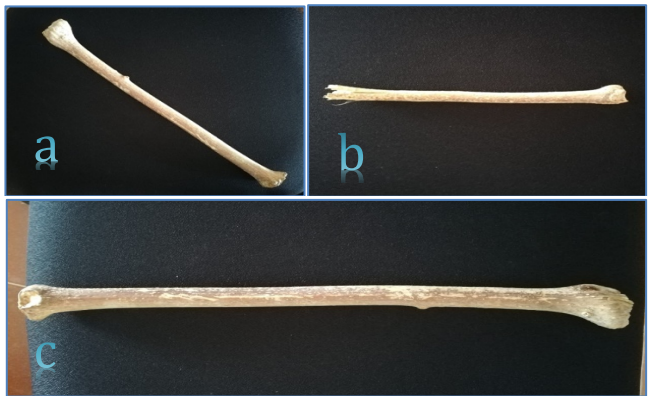
3.4 Forensic Ecology:

It deals with the knowledge of the relationship between the plant and animal species in a habitat in forensic investigations. This helps to investigate whether the suspect could be held guilty of the crime

that he is denying.[2] A case of murder reported in Dundee, United Kingdom was solved based on the comparison of botanical evidence found on the footwear of the suspect and the soil & vegetation at the scene of crime.[16]

The ecological profiles of seeds found on any moving object can help to identify the types of environments through which the object had travelled. This approach in crime scene investigation is very useful but it requires a sound knowledge of the different seeds and its origin.[17] Traces of the seed or its constituents can be collected from gastric contents because of its resistivity in gastric juices. In the case where unidentified torso of 4–7-year-old boy without limbs and head was found in Thames River in London, the DNA analysis confirmed his origin from Africa. But the seeds that were recovered from his stomach matched with a plant native of Europe. Further investigation based on these scientific evidences reported the case as human sacrifice.[18]

Fig 2: Piece of wooden part of plant misinterpreted as bone/fragment in first instance (a,b,c) (Photo Courtesy: Department of Forensic Medicine, Yenepoya Medical College, donated by Dr Nasir).



Manvailer *et al.,* [2018] from Brazil conducted a study and reported that the proper method for preservation or preparation of a given botanical trace depends on the nature of the sample and the type of analysis, if a forensic investigator who is skilled in proper collection and preservation may save the evidences and prevent loss of trace evidence.[19,20] Sometimes plant materials are mistaken as skeletal remains (**fig 2**) and collected from crime scene but once it is confirmed it may be left out, if the plant material is examined properly it may also provide a substantial support for the forensic investigations. Ellis [2014] stated that there is a need to realize the full potential of forensic botany in crime scene investigations. The article explains the application of forensic botany by the case studies. One of the cases, related to kidnapping of Jaycee Dugard remained unsolved for 18 years. The main reason was improper handling of the evidences and lack of basic knowledge about the soil & vegetation of the crime scene by the forensic investigators.[21]

The pollens can easily adhere to the hair of the victim or suspect thus through palynological study of human hairs, places of interest can be located and trace evidence can be provided to link people and objects with crime scenes in India.[22] Botanical investigations helped in identifying the murder weapon used to kill a young girl who was last seen with her male friend. The presence of wood splinters embedded within the cranial fracture led to the murder weapon, a block of wood found in possession of the male friend which was cut from the trees at the crime scene.[4] Even with a vast application, there are several limitations to be addressed for future to apply the forensic botany in forensic contexts. Plant genes unlike animals cannot be bar-coded, limiting identification of plant fragments as evidence from crime scene, however DNA of bryophytes remain intact for a long time and can be used as evidence. In some countries Pollen is not accepted as evidence in court. Collection of evidence from crime scene is crucial and should be collected carefully by an expert to avoid contamination

4. Summary & conclusion

- Forensic botany involves the identification of the plant species based on its morphology, anatomy or microscopy. After the species has been identified by its unique characteristics, an attempt is made to individualize the samples.
- Forensic botany can only concretely assist the forensic pathologist or investigators if the collection of botanical evidence has been carried out by forensic experts. Plant materials can provide important trace evidence as seen in cases of food adulteration and consumption of poisonous plants.
- Palynology can complement forensic DNA by giving proof to the presence or absence of people or objects in a particular place in a certain time-frame.
- There is a need for a multidisciplinary approach and to include a Forensic Botanist as an expert in the team when crime scene investigations have to done.
- There is need for recognition, collection, and preservation of botanical evidence as in Indian context where the flora of every region is different

- To develop and compile to test the plants trace elements at macroscopic, microscopic and molecular level is the need of the hour.

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