FORENSIC BOTANY

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Introduction

This article introduces aspects of botany that are useful in courtroom evidence concerned with crime-scene investigations, relationships among victims, associations between victims and suspects, victims/suspects and crime scenes, and the time of death of a victim. Botanical science is also useful in finding clandestine graves. Forensic botany applies the knowledge and techniques of plant science to legal matters, especially those related to crime. This article is based upon experience with the applications of three aspects of botany in criminal, especially homicide, investigations. These uses come from: (1) plant anatomy; (2) plant taxonomy; and (3) plant ecology. Two other aspects of botany used in forensics, plant DNA and palynology, are discussed in passing. Examples from cases can be found in the journal articles cited below. The cases we have dealt with have originated from investigators and attorneys involved in criminal justice.

Plant Anatomy

Plant anatomy is the study of plant cells. This botanical subdivision has received little attention by forensic scientists. It is here that certain aspects of forensic botany have developed lately, although the techniques used are as old as the field itself. Every kind of plant, including plants used for food, has specific patterns of cell types with distinctive sizes, shapes, and inclusions. These characteristics allow individual food plants to be identified readily in samples from the human digestive tract. Plant cells pass through the human digestive tract without losing their identifying characteristics. They also maintain these characteristics in fecal material. This is because cellular size, shape, and structure are defined by the plant's cell wall. Cell walls of plants have cellulose as their principal structural component. Cellulose is nonliving and

it surrounds the internal contents of cells by means of interwoven strands. Cellulose is a polysaccharide. It is indigestible by humans and passes through the human digestive tract intact. Therefore, as long as some or all of a victim's digestive tract is present we can often identify specific plant foods from their cells in stomach, intestinal, and fecal samples from meals near the time of death.

The forensic use of plant cells from the human digestive tract requires a limited amount of special training, but the laboratory techniques are simple. For example, food contents of a victim's last meal may indicate the place where the meal took place, with whom the meal was or was not taken, false testimony and, within broad scientific guidelines, general information about the time of death. This evidence has been widely accepted in criminal courts.

The technique used for identification of food plant cells is as follows. Samples of digestive tract contents are received. Slides are prepared from those samples for light microscope examination. Staining is not essential, but a drop of safranin or similar stain may be used. These slides are examined, and indications of food plant possibilities are likely to be suggested to the experienced plant anatomist. Slides are then prepared from known food plants. The plants to be used for comparison usually are obtained from a grocery store. Whether the store's material is fresh, canned, or frozen is irrelevant. The guidance for identification may come from either our out-of-print guide which was widely distributed at publication to investigators and to forensic laboratories in the USA and Canada, or, quite often, from the plant anatomist's previous experiences. In order to double-check our identifications, known samples are prepared and compared. It is highly desirable that at least two people, working independently, affirm the identification.

Plant cells in a victim's stomach contents sometimes provide clues about the time of death. At death the pyloric valve at the base of the stomach closes and remains closed until decay is advanced, holding most, if not all, the contents of the last meal in place (Table 1). This is not true of food found elsewhere in the digestive tract where valves do not necessarily seal at the time of death. Only stomach contents have been used in discussions and testimony concerning time of death.

Table 1 Human digestion times for a meal: times are compiled from scientific literature concerned with human digestion[a]

Location	*Range of time*
Mouth	1 s–2 min
Stomach	2–6 h
Small intestine	2–8 h
Large intestine	6–9 h
Total time	10–23 h

[a]These figures are only rough guides and may be influenced by drugs, diseases and many other factors.

Plant Taxonomy

A second kind of useful botanical evidence in crime-scene investigation uses information from plant taxonomy. This field includes plant species identification. Plant materials may be found in and on vehicles. Such materials have been used to link suspects to a crime scene, a suspect to a victim, and victims who have relocated have been linked to the original crime scene. Materials have also been identified from the clothing of suspects and victims, and from the bodies of victims. Very small pieces of leaves, twigs, and flowers can often be identified from species using relatively simple and readily available guides. This work has led us to encourage crime-scene investigators to look for plant fragments before using a vacuum sweeper. People with the appropriate backgrounds to carry out such identifications in an expert way are readily available throughout most of the world.

Plant Ecology

Plant ecology is the discipline that investigates plants and their environmental relationships. In the search for clandestine graves, ecological knowledge of patterns of plant succession is useful. Disturbance patterns of the soil and vegetation over graves vary in known ways and are dependent upon time since burial, decomposition of the corpse, and regional climate, among other factors. In addition, ecological knowledge of patterns of plant distribution has been useful in pinpointing crime scenes. Regional experts are available in most parts of the world. Ecological knowledge often complements the findings of plant taxonomy because plants are often highly specific in their environmental requirements and their natural distributions. For example, in Colorado, we have been able to associate plants from a crime scene with certain mountain elevations that were distinctive from the plants found elsewhere in the state.

Palynology

Palynology is a subdivision of plant science and geology that deals with pollen and spores. Pollen grains carry the sperm involved in sexual reproduction of vascular plants. Spores are cells that are involved with nonsexual reproduction in fungi and plants. Geologists have long made use of fossil pollen and spore patterns in their searches for fossil fuel deposits. Such cells can also be used to reconstruct climates of past

times as well. For example, near Boulder, CO, in the USA, there are many pollen fossils of palms and redwood trees, bearing witness to a milder, wetter climate than exists there at present. Forensic scientists make use of pollen and spores as well. If pollen and spores are identified on the clothing of a victim or a suspect, they can act as witness to where these people have been. In addition, seasonality may figure in an investigation because pollen and spore dispersal are seasonal as well as place-specific.

DNA Analysis for Botanical Materials

DNA work on plants is available from a myriad of sources that carry out DNA analyses. The most common practice is to use chloroplast DNA for such purposes; but mitochondrial and nuclear DNA from plants can also be used. Such evidence has been useful in a few well-publicized cases, but it is less useful in general for plant evidence than for that involving humans because humans belong to only one species and our entire complement of DNA has been analyzed. The DNA of most of the 270 000 species of flowering plants has not been investigated.

Education

Presently, there are no formal training programs or board certifications in forensic botany. The persons who qualify as expert witnesses in plant anatomy work have rather specific educational and experiential requirements. Advanced training in botany is essential (masters or doctoral degree) and some training in crime-scene investigation, courtroom testimony and evidence presentation, as well as appropriate professional affiliations, is important. Certainly, self-education is possible to a considerable extent if the investigator can obtain a plant anatomy textbook for serious study and, using a light microscope, prepare and examine food plant materials.

The Use of Botanical Evidence in Forensic Testimony

Far too few forensic laboratories make use of the inexpensive, strong evidence that can come from forensic botany. Many aspects of botanical knowledge are useful in detection and in courtroom testimony in criminal cases. Sometimes expert witnesses require highly specialized training to be received as experts in court, but there are many botanists throughout the world with credentials and knowledge that will fit them for giving testimony and depositions. Botanical evidence as described here calls for relatively inexpensive techniques to produce credible evidence.

See Also

Autopsy, Findings: Organic Toxins

Further Reading

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