Forensic Palynology

Introduction
Forensic palynology (pollen analysis) is the study of pollen and spores, applied to solving legal issues. It has been used as a forensic tool for over 50 years, but has only recently become a more widely used technique (Mildenhall, Wiltshire & Bryant 2006).

The basis of palynology comes from the unique characteristics of pollen. Owing to their hard, durable coating, pollen grains are a long-lasting form of evidence. Pollen is ubiquitous, being found wherever plants are, and is easily transferred to clothing, people or other objects. Being microscopic, a suspect will not know that pollen has been transferred onto them, and the grains are difficult to completely remove, even by washing (The Forensics Library n.d.).

Collection and Analysis
Evidential pollen samples can be collected from virtually any object, including people, clothing and parts of vehicles, e.g. wheels, mudguards, air filters. Samples can be taken using a soft sable brush, cellophane tape, a portable vacuum cleaner, or other methods (Bryant, Jones & Mildenhall 1990). Comprehensive site surveys and photographs of the crime scene or suspected area(s) need to be taken, in order to determine the plant species in the area and their relative abundance. Botanical reference samples of each plant should also be collected, if possible. Ideally, the palynologist will be among the first to the crime scene, to prevent the contamination of pollen samples.

Control samples, which represent the typical pollen makeup of the crime scene, are usually taken from topsoil in the surrounding area. The collector must ensure that sufficient control samples are taken, and that they reflect the typical composition of the area. The evidential samples are later compared to the control samples; the closer their similarity, the higher the chance that they came from the same area.

All samples should be stored in sterile, airtight containers such as Ziploc bags, and labelled with a unique identification number. A record must be kept of the chain of custody of each sample in order for it to be presented as legal evidence (including who had it at what time, and the conditions under which the container was opened). Avoiding contamination between when a sample is collected and when it is examined by the palynologist is of the utmost concern (Bryant, Jones & Mildenhall 1990). Damp samples must be dried in an oven before being stored in a fridge or freezer, as mould or fungi may otherwise destroy the samples. Any plant material for identifying the vegetation in the area should be pressed and dried.

Recovering pollen from a sample can be done several different ways, so the method used should be chosen at the discretion of the palynologist. However it typically includes removing mineral and organic matter through acid treatment, sieving, and staining to view the pollen grains (Korejwo et al n.d.). As it is usually a destructive technique, pollen analysis should be the last analysis conducted on a sample (Bryant, Jones & Mildenhall 1990).

Pollen analysis is usually conducted under a light microscope, however SEM (Scanning Electron Microscopy) and QEMSCAN (Quantitative Evaluation of Minerals by SCANning electron microscopy) may be useful, or even necessary, in some cases. Pollen grain size can provide some identification
information, although it does vary, even from the same plant. Morphological features such as shape, surface patterns, aperture type, wall structure, wall thickness, and variations in the thickness around the grain are often used for identification (Mildenhall, Wiltshire & Bryant 2006; The Forensics Library n.d.). Comparison to pollen from a reliable reference source is necessary for giving evidence in court; identification based solely on images may not be accepted.

Palynological Evidence

There are five broad categories of plants, based on their method of pollen dispersal. Each group has a different potential in forensic cases.

<table>
<thead>
<tr>
<th>Type of plant</th>
<th>Mode of pollen distribution</th>
<th>Use in forensic investigations</th>
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</thead>
<tbody>
<tr>
<td>Anemophilous</td>
<td>Wind</td>
<td>Most common type of pollen, preserves easily, found on most surfaces. 95% of pollen falls &lt;2km from parent plant.</td>
</tr>
<tr>
<td>Hydrogamous</td>
<td>Water</td>
<td>Decompose rapidly; of limited use except in cases with an aquatic aspect.</td>
</tr>
<tr>
<td>Zoogamous</td>
<td>Animals</td>
<td>Very durable pollen; sticks to most surfaces; usually only found very close to the parent plant. Excellent potential in forensics.</td>
</tr>
<tr>
<td>Autogamous</td>
<td>Self-fertilising</td>
<td>Very few pollen grains produced per flower. Rare in forensic cases but significant if found.</td>
</tr>
<tr>
<td>Cleistogamous</td>
<td>Closed reproductive system</td>
<td>Found in many cereal grasses. Fairly rare; can be found on objects that brush against the plant.</td>
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</tbody>
</table>

(Information from Mildenhall, Wiltshire & Bryant 2006)

The species and abundance of each pollen type often forms a distinct 'fingerprint' of an area, so samples can commonly be traced to a small number of potential areas. Some areas contain fossilised pollen, which can provide strong evidence if found in an evidential sample (Bryant, Jones & Mildenhall 1990; The Forensics Library, n.d.). In addition to plant species and abundance, mapping the pollen types on clothing can provide further clues about where a person has been. For example, a large amount of pollen on the shoulders of a shirt might indicate that the wearer was waiting under a tree for a long period of time.

Palynology can be used to link suspects or objects to a particular scene, provide information about the type of environment or geographic location that an object or person has been in, and prove or disprove alibis. In some cases it can also be used to estimate the time of year that a crime took place (The Forensics Library, n.d.).

In most situations, palynology will not provide conclusive evidence that a person or object came from a particular area; instead the analysis will usually provide circumstantial evidence, with a calculated probability that the samples came from the same area (Bryant, Jones & Mildenhall 1990).

Palynology in Australia

The main online resource available to Australian palynologists is the Australasian Pollen and Spore Atlas (http://apsa.anu.edu.au/), which contains over 15,000 species in its database. Although this source may be very useful for preliminary identification, it is necessary to identify unknown taxa
using reference pollen grains, from a pollen collection or sourced from a herbaria, in order to give legal evidence (Mildenhall, Wiltshire & Bryant 2006).

The University of Western Australia currently appears to be the most involved in palynology, and offers courses in forensic palynology. Murdoch University also offers forensic palynology courses as part of its Forensics Biology and Toxicology major.

Some studies, such as that conducted by Bruce & Dettmann (1996), have looked at the palynological composition of soils in certain areas of Australia, and may be useful when trying to match an unknown sample to a location. However, these studies are generally too few and sparse to be of use in most cases.

**Conclusion**

There remains much room for improvement in Australian palynology, including further surveying of pollen profiles to build up better pollen maps of Australia, photographing pollen from species not included in the Australasian Pollen and Spore Atlas, and the creation of reference pollen collections for local forensic units. Although forensic palynology is slowly becoming a more widely used technique, all forensic personnel should be trained in proper technique for collecting pollen samples, as there are not enough palynologists to attend every crime scene and collect samples. Forensic palynology has come a long way since its beginnings, and with continuing hard work, it will become yet another powerful weapon in the fight against crime.

**Bibliography**


