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Consideration of some taphonomic variables of relevance to forensic palynological investigation in the United Kingdom

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Abstract

Palynology is a long established and respected branch of environmental science that has been applied to criminal investigation in a meaningful way only in recent years. It has proved to be remarkably versatile in many kinds of criminal enquiry. It is not, however, an absolute science; palynological data are on a par with the suites of symptoms which allow medical practitioners to make diagnoses. Taphonomic variability is the main factor complicating interpretation of forensic palynological data. Palynological taphonomy may be defined as ''all the factors that influence whether a palynomorph (pollen, spore, or other microscopic entity) will be found at a specific place at a specific time''.

If taphonomic variability is anticipated, and regularly tested, palynology will continue to keep its place in the armoury of useful forensic methods. Some assumptions made by palynologists engaged in palaeoecology and archaeology have been shown to be untenable in the forensic context. Palynological and botanical profiling of crime scenes has demonstrated anomalies which challenge received wisdoms. It has proved impossible to obtain palynological population data because every site is unique—expectations of any palynological profile can only be crude. The palynological status of any place must be tested every time. Without a body of analytical data from the actual crime scene, it is difficult to see how any palynologist can hope to present credible arguments under cross-examination. The statements made in this paper relate mainly to work carried out in the United Kingdom.

Keywords: Palynology; Pollen; Taphonomy; Crime scene; Airspora; Shoes; Clothing; Vehicles

1. Introduction

The application of palynology to criminal investigation has achieved momentum only in recent years. Those of us (and we are few), who are routinely engaged in forensic investigations have only our training, experience, and enthusiasm for continued and painstaking research to enable us to be of real practical help to the investigating authorities. None of us was trained as a forensic palynologist, and there are no established courses in forensic palynology. This is a subject not easily taught as it requires a great deal of botanical, ecological, and other environmental experience. The palynologist also needs to have the personal resources necessary to cope with the challenges presented by the police and the witness box. The value of the forensic palynologist thus depends on the individual skill and experience of the practitioner. As yet, there is no absolute benchmark for validation. Accreditation comes from repeated achievement of outcomes that prove to be of real value in criminal investigation—ones that are scrutinised by peers employed by the Defence, yet pass the test.

All competent palynologists, whatever their basic environmental training, will have knowledge of the literature that will aid interpretation of their data. However, when viewed critically, there is surprisingly little published information that is of practical value in the forensic context. Much of it is highly theoretical [1], or based on remarkably small data sets [2,3] in which case they would certainly be insufficient to stand cross-examination in the British courts. To date, the most useful papers are those which demonstrate principles through case studies [3–5]. Even here, the actual numerical and statistical data presented are sparse because the authors are attempting to present general principles. However, because of the dearth of results, they are often difficult to evaluate critically.

Palynological data are probabilistic, and their quality is constantly under scrutiny in British criminal cases. Generally,

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little credibility is given to analyses where data are few but, in some cases, the results are clear and provide compelling evidence [6]. In others, even where extensive results are obtained, they can be so complex and varied that they defy interpretation. Whatever the nature of the case, standard protocol should ensure that sufficient comparator (control) samples are collected to facilitate an adequate understanding of palynological patterning at scenes of crime, and/or the palynological profiles associated with critical items. A comparator sample can be taken from any surface, matrix, or object which might have been contacted by any exhibit being investigated. Palynomorph assemblages from comparator samples are for comparison with those from the pertinent exhibits. Some investigations are highly complex and it is often necessary to obtain comparator samples from surfaces, matrices, or objects other than those associated with the crime scene itself. This is because of the phenomenon of multiple deposition of palynomorphs during normal use or wear of the exhibit. Such "innocent" comparators are necessary for elimination purposes.

Over the last few years in Britain, forensic palynology has helped to:

1. Link offenders or their belongings with places and other objects (trace evidence).
2. Predict the location of places from the pollen assemblages associated with suspects or their belongings (search and location).
3. Estimate the length of time human remains, or objects, have lain *in situ*.
4. Differentiate murder sites from the places victims are dumped.
5. Give information on the *peri-mortem* fate of victims.
6. Provide limited temporal information on *post-mortem* interval through gut analysis.
7. Establish food intake prior to death through gut analysis.

After being engaged in forensic palynological investigations in all parts of Britain for many years, the author has collected a large database of palynological profiles from very many comparator samples taken from crime scenes, and other places pertinent to specific criminal cases. This record also includes profiles obtained from a wide range of objects, and from human remains. While there are too many data to present here, some idea will be given of the extreme spatial heterogeneity of pollen and spore assemblages.

The body of results accrued over the years has made it clear that the only truly predictable aspect of the spatial patterning of pollen spectra is its unpredictability. This is due to the mass of taphonomic variables inherent in the pollen and spore accumulation in any natural or man-made environment. No crime scene can be taken for granted. It must be evaluated both by eye, and through analysis. Furthermore, very little accurate prediction can be made of the profiles that may be retrieved from various objects and from cadavers. The success of palynology in forensic investigation depends on rigorous analysis, the botanical and ecological experience of the analyst, and the cooperation of investigating officers.

In terrestrial environments, spores are released from the sporangia of mosses, liverworts, and ferns (and their allies). Pollen grains are released from the male cone sporophylls in conifers, and from the anthers of flowering plants. The spore needs to land on a suitable substrate for germination and development of the next generation. The pollen grain's function is to reach the female and facilitate fertilisation of the ovule; this leads to seed production. The spores of mosses and ferns, and the pollen grains of conifers and flowering plants, lack motility and are carried away from the sporangium or anther by vectors [7–10].

The method of dispersal evolved by any plant species must ensure that sufficient spores or pollen will reach their functional destination; dispersal mechanisms will, therefore, influence the level of production. Successful plant spores will germinate to form new generations of mosses and ferns. Successful pollen grains will reach the female members of the species and fertilise the ovule within the ovary. But the vast majority will simply land on the ground (or some other surface) and die very quickly. The dead spore or pollen grain might decompose and disappear, or remain intact for variable lengths of time.

Palynological taphonomy may be defined as all the factors that influence whether a palynomorph (pollen, spore, or other microscopic entity) will be found at a specific place at a specific time. It is obvious that this is highly complex and involves a multiplicity of variables, including those discussed below, such as production, dispersal, and survival. For any one situation, many of these variables will remain unknown.

2. Production and dispersal

Obviously, the numbers of spores and pollen grains produced by plants, and their mode of dispersal, will affect the frequency with which they are encountered away from the parent plant. Most pollen is transported various distances away from donor plants and, in temperate ecosystems, the *main* vectors are insects (entomophily), and wind (anemophily).

A great deal of effort has been made to gain some insight into the amount of pollen produced by various species of plant. Some workers have estimated the absolute numbers of grains produced in each anther, by each flower, or shoot [11,12] whilst others have estimated relative pollen production of plant species and even attempted to apply correction factors for the various plant taxa [13–15].

Generally, pollen production in entomophilous taxa is relatively low, and the plants' resources are channelled into features which encourage insect vectors. These involve production of nectar, perfume, colour, and a tendency towards zygomorphic flowers to support, or even trap, the insect during its visit. Some, such as *Salix* (willow), have exposed anthers so that wind can also play an additional role in dispersal, but the reliance on insects of others, such *Hyacinthoides non-scripta* (bluebell), and *Digitalis purpurea* (foxglove) means that their pollen rarely, if ever, moves far from the immediate vicinity of the plant [16]. In plants such as *Aristolochia* (birthwort), *Arum* (arum lily), the Orchidaceae (orchids), and others, their extreme adaptation to entomophily