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Application of Judicial Palynology in Judicial Identification

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ABSTRACT Judicial palynology is a branch of forensic science. Palynological examination can provide important information for inferring the relationship between suspects and crime scenes, the time of occurrence of cases and the source of drugs. In New Zealand, the United Kingdom, the United States and other countries, sporopollen testing has played an important role in the detection of a number of cases, other countries in recent years have also carried out relevant applied research. This paper summarizes the typical cases of forensic palynology in the past 50 years, introduces the history and current situation of the subject, and probes into its future research focus and development direction in order to improve people's comprehensive understanding of the subject and strengthen its application in forensic identification in the future.

KEY WORDS Forensic palynology; Forensic science; Forensic medicine.

I. OVERVIEW OF JUDICIAL PALYNOLOGY

In 1944, British botanists Hedy and Williams [1] proposed the term "palynology" and established a branch of botany with spores of fungi, algae, mosses and ferns and pollen of seed plants as research subjects. With the development of palynological research, its scope has expanded from biology to geology, medicine, environment, Archaeology and forensic science [2-4].

Forensic Palynology refers to the science of associating suspects, victims and crime scenes through the study of spores, pollen and other microorganisms in various cases [5]. Edrtman (1969) first explored the preliminary application of pollen analysis in Criminology and laid the foundation of forensic science for judicial palynology [6]. Thereafter, many countries, such as New Zealand [7-17], Britain [18-25], Australia [26-28], and the United States [1, 29-34], have carried out the application of forensic palynology. In New Zealand and the United Kingdom, for example, since the 1980s, New Zealand palynologists, represented by Dallas Mildenhall, have begun to conduct judicial palynology, which has become a conventional technology in New Zealand. Similarly, the technology was rarely used in the UK before 1990, but has since been widely used with the vigorous push of forensic scientist Patricia Wiltshire. In contrast, the application of judicial palynology in Canada [35-36], Italy [37-38] and Spain [39] is relatively lagging behind. In recent years, our country has also started the application research of judicial palynology. There have been some successful cases [2-4, 40-46], which shows the practicability and effectiveness of judicial palynology.

II. THEORETICAL AND PRACTICAL BASIS OF JUDICIAL PALYNOLOGY

Judicial palynology is based on Locard Exchange Principle (LEP), that is, the transfer of biomass between criminals and related objects or places. There are two ways of transferring this process, one is that the criminals leave material at the crime scene, the other is that the criminals take material from the crime scene [27,47]. Simply put, any contact must leave traces. When a criminal enters the scene and commits a crime, the surface of the object he touches will exchange substances with his body, leaving traces (such as fingerprints, dust, blood, skin cells, fibers or metal debris), and his body will also be stained with traces from the surface of these objects. Even if the criminals deliberately clean up, it is difficult to completely eliminate these traces. When criminals commit crimes, sporopollen will attach to criminals by means of clothing, dust and other carriers, thus leaving traces and taking them away from the scene. Therefore, by analyzing the sporopollen combination of clothing and mud on the criminal's body, we can judge and trace the corresponding vegetation and environmental conditions at the crime scene.

Spores and pollens (sporopollen for short) provide a common source of material transfer for exchange in the context of soil and dust particle transfer. Its characteristics and characteristics are as follows:

1) small size, usually only tens of microns (up to hundreds of microns), invisible to the naked eye, need to be observed and analyzed by microscopy; widely spread, air, soil and other environmental and object surfaces are ubiquitous; because sporopollen outer walls are rich in sporopollen, so the outer walls are strong, resistant to degradation in nature, and can be preserved for a long time [3,19,44,48].

2) Although the sporopollen size is small, its size, shape, types of germination holes (ditches) and surface ornamentation and their combinations are rich and diverse, and there are great changes among different plant groups (Fig. 1). According to the difference of morphology and structure, the phylum, class, order, family, genus and even a few special plants can be identified and compared effectively.

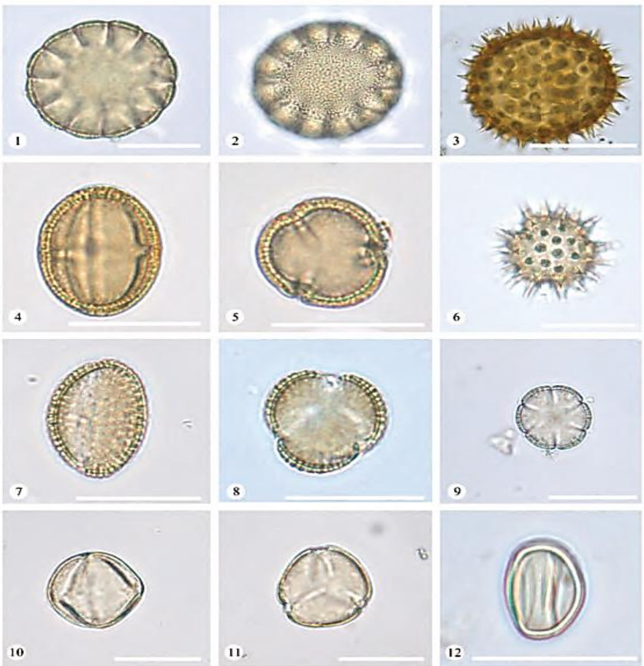

Figure 1: Exampled samples of form-and-structure-diverse pollens (Observed under microscope at the scale of 20μm for all pictures with the exception of the picture-3's 50μm) (1 and 2, sesame's; 3, cotton's; 4 and 5, buckwheat's; 6, helianthus'; 7 and 8, cole's; 9, thyme's; 10 and 11, purple alfalfa; 12, bramble's)

3) In addition to the differences in morphological structure of sporopollen in different plant groups, the characteristics of "sporopollen assemblages" are also different due to the different geographical and regional plant diversity. According to the different combinations of sporopollen in different geographical and geographical units, fingerprints similar to human are different. These sporopollen "fingerprints" can be used for spatial tracking in criminal investigation [7,19,31,36,48].

4) Different plants have specific flowering periods in different geographical locations. Pollen concentration in flowering period is higher and the geographical combination of plants is different. It can be used to assist inference and even to determine the time of the case [19,49].

III. APPLICATION CASES OF JUDICIAL PALYNOLOGY

Judicial palynology has a wide range of applications and can be used in many types of cases such as theft, murder, rape, and drug trafficking. We have reviewed the application cases in the past 50 years and can be divided into the following types:

1. Determine the Relationship between the Suspect and the Crime Scene

Case 1: In 1959, a man disappeared in the Danube River Basin. After careful investigation, the police found a suspect, but there was no direct evidence to convict him. Through sporopollen analysis of the suspect's shoe mud, it was found that the main sporopollen assemblages included modern plants such as Picea asperata, Salix and Alnus cremastogyne, and fossil pollen of Carya in the Miocene. The characteristics of this assemblage were consistent with the vegetation in northern Vienna. The police finally found the victim's body in this area [6].

Case 2: In the case of a theft in New Zealand, the thief escaped and encountered the flowering Hypericum plant in the courtyard. Afterwards, the police arrested a suspect and found a large amount of hypericum pollen from his clothes, and the pollen grains collected directly from the plant were identical in size, shape, color and other characteristics. It was confirmed that the suspect had recently been exposed to this plant [14].

2. Overturning the Evidence of Absence

Case 1: A New Zealand suspect was arrested for escaping the police and was caught in a corn field that was in its flowering period. He was later arrested, but he denied going there. The large amount of pollen on his shoulder was identified as corn. Pollen, according to which the overdue evidence was overturned [8].

Case 2: In a British rape case, the suspect claimed to have had a sexual relationship with the victim in a park not far from the crime scene. Through sporopollen analysis and comparison, the results show that the sporopollen combination of clothing and shoes is consistent with the crime scene, and is inconsistent with the park, thus negating the suspect's statement [24].

3. Determine the Source of the Drug and the Route of Transportation

Case 1: A large amount of cannabis resin was seized at a port in New Zealand and sporopollen analysis was carried out to identify its source. No pollens of common plants in New Zealand, such as Nothofagus, Podocarpus and Dacrydium, were found. However, cannabis and Artemisia were abundant, with an average relative abundance of 88% and 10% respectively. Pollen, as well as pollen from exotic plants such as Chenopodiaceae and Impatiens, which were not recorded in New Zealand archives, showed that cannabis resin was imported [8].

Case 2: A batch of cocaine was seized in New York, USA. The police sent the samples to the police for inspection, hoping to find out their sources and smuggling routes. Pollen assemblages of tropical plants growing in Bolivia and Colombia, as well as pollens of Pinus banksiana and Tsuga canadensis, Common Weeds in New York and Manhattan islands in North America, are abundant. According to the sporopollen assemblages, the samples may have originated in South America, then packed and packed in North America, and then smuggled to New York [31].

4. Determining the Scene of the Crime

Case study: A female corpse was found in the forest on the south side of a farm in China, but it is not clear whether the forest on the south side or on the north side is the first scene. The sporopollen samples of the dead shoe mud and the soil samples of the two sides of the forest were examined and compared. The results showed that the sporopollen assemblage of shoe mud was the same as that of the northern forest soil, and there was a significant difference between shoe mud and the southern forest. Finally, the police helped to identify the northern forest as the first scene [43].

5. Determine the Time of the Case

Case 1: In a murder case in Switzerland, the suspect claimed that his gun had been sealed in a box after wiping oil a few months ago, but after sporopollen analysis, the oil on the gun was found to contain pollen from Alnus cremastogyne and Betula sp., both of which were pollinating at the time of the murder, and the suspect's alleged time was significantly earlier than the pollination period of the two plants because This proves that the suspect is lying [50].

Case 2: In February 1994, 32 male corpses were found in a grave in Magdeburg, Germany. There are two main ways of identifying the dead and murderers. One is that the victim was killed by Gestapo in the late spring of 1945. The other is that the victim was a Soviet soldier who refused to attack the German Democratic Republic on June 17, 1953 and was killed by the secret police of the Soviet Union. Through pollen analysis of 21 skulls, a large amount of plant pollen (e.g. Plantago asiatica) grown in summer was found in 7 of them. Therefore, it is inferred that the time of death of the victim occurred in June or July [51].

6. Reduce the Scope of Investigation

In the investigation of an anonymous corpse case in China, the Center for Pollen Application of Tongji University, through sporopollen analysis of the clothes of the deceased and the remnants of their oral and nasal organs, narrowed the source of the deceased to the western Sichuan and northwestern Hubei regions of the middle and upper reaches of the Yangtze River according to the characteristics of sporopollen assemblage, provided an important clue for the case detection, and finally identified that the deceased came from Xichang, Sichuan [42].

7. Determine the Cause of Death of the Victim

In a Brazilian case, a young boy died after eating honey, but the cause of his death was unknown. Forensic doctors detected toxic plant pollen in the contents of their stomachs to determine the cause of the boy's death [6].

IV. OUTLOOK

Although many countries have gradually applied forensic palynology to practical cases, there is still much work to be done in order to achieve the wide application of forensic palynology in forensic identification.

1) Strengthen publicity and popularization. Superior departments should take measures to publicize and popularize the knowledge of evidence and evidence collection such as sporopollen science. By publicizing a large number of cases, the investigators at all levels, especially the front-line forensic doctors, should strengthen their awareness of understanding and forming the use of sporopollen evidence, and clarify the characteristics of sporopollen science and the value and significance of its utilization in the light of previous cases.

2) Establish and improve the standards and regulations for the collection process of sporopollen evidence. To organize relevant experts to study and establish standardized collection, preservation and inspection methods, incorporate the use of judicial palynological evidence into the process of criminal investigation evidence collection, play a key role in case detection or the collection of evidence samples is scientific and complete, ready for emergencies.

3) Strengthen the construction of database infrastructure platform. Pollen fingerprints are like human fingerprints. On the basis of comprehensive investigation and understanding of sporopollen temporal and spatial patterns in different geographical units and SPOROPOLLEN ASSEMBLAGES in different ecosystems, we need to obtain the large data of characteristic SPOROPOLLEN ASSEMBLAGES in different regions and seasons, construct a perfect sporopollen database platform, develop sporopollen rapid identification software, and realize sporopollen physical evidence. Quick identification and accurate comparison will help public security organs to find out cases.

4) Strengthen the construction of experimental facilities and technical system. Judicial palynology, like other branches of forensic science, requires standardized and specialized palynological laboratories, as well as sophisticated analytical instruments. It is suggested that judicial palynological laboratories should be built in order to provide centralized services. At the same time, a set of mature sporopollen analysis technology system is constructed to effectively improve the value of sporopollen evidence, aiming at different carriers in the case scene, such as shoe mud, clothing, hair and so on.

5) Strengthen the training of professional talents. The professionalism of forensic palynology and the need for

environmental analysis at the trace level determine that the technician involved in the work must be a palynologist with judicial experience. However, there is currently a shortage of experienced judicial sporopollen professionals, and there are scarcity of institutions or related training institutions in the profession. Therefore, in the future, we should focus on strengthening personnel training in this area. For example, national or provincial-level functional organizations organize national key training courses to train the backbone of training.

6) Strengthen applied research. In view of the fact that judicial palynology is rarely used in developing countries, while strengthening basic research, it is necessary to strengthen cooperation with the actual combat departments of public security and judicial organs, popularize, popularize and demonstrate the built platform and technical system, and gradually apply these technical platforms to actual cases.

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