Pollen as Evidence: Testing the Viability of Pollen and Spores in Forensic Investigations in an Arctic Environment

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Introduction:

Forensic Palynology is the study and use of pollen and spores to aid in criminal investigations. The field is a relatively young one with the first known case of pollen being used in an investigation dating back to 1959 when pollen was used to solve a murder case in Austria (Bryant, et al., “Pollen - Nature's Tiny Clues”).

The basic underlying theory of the field is that pollen and spores can serve as unique indicators that help tie people to a crime scene. Pollen is microscopic, so offenders may leave with some on their person without even noticing. It is also incredibly resilient as a structure and does not decay easily. This not only means it can last on a piece of evidence potentially longer than other evidence types, it also means it could survive clean-up attempts by offenders (Bryant, et al., “Pollen - Nature's Tiny Clues”). Finally, pollen is unique. Each species of plant, based on current understanding, produces a uniquely shaped/structured pollen spore. As such, pollen can be used to determine plant life that suspects or evidence have come into contact with, and thus identify the locations they have been around or through. This helps tie them to the crime scene or track their line of actions (Bryant, et al., “Pollen and Solving Crime”).

Since the field is young, much research is still being done into its uses, effectiveness, and the proper ways to perform pollen collection and analysis. For example, recent research reveals pollen collections can be surprisingly simple. Adhesive tape can be easily applied to evidence to strip off any pollen collected (Wu, et al.). This gives the field another advantage of being cheaper and easier to pull off than other forensic fields.

But other questions remain. For example, more research is needed into whether pollen evidence is more useful in certain environments or during certain times of the year or on how specific a location it can reveal to us. Take for example, the Arctic. This is an ecosystem where pollen producing plants aren’t always in bloom, and the time period during which they do is very short. So in an environment where pollen is seemingly lacking, can it still be used as evidence?

Research Questions and Hypotheses:

Our primary research question is two-fold: is pollen evidence a viable source of forensic evidence in an arctic environment, even before the peak of the blooming season, and how specific a location can pollen tie a piece of evidence to?

To test this, we ran clothing (a common piece of evidence in forensic investigations) through five different crime scene scenarios (described in “Methods”)

Our hypothesis is that pollen evidence will be viable in all outdoor scenarios, but not for clothing kept indoors where it would be protected from pollen exposure. We also predict that the pollen will be able to tell us what specific part of the environment the evidence was left in based on the unique pollen composition found on each piece of evidence.

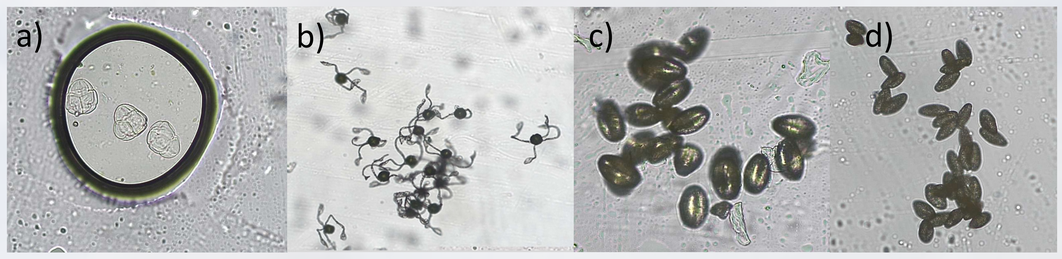

Figure 1: Known Pollen Samples – Pictured above are some of the pollen and spore samples collected from flora local to Kilpisjärvi that were used for reference. a) Bilberry (European Blueberry) pollen, b) Horsetail spores, c) Marsh Marigold pollen, d) Willow (Salix) pollen.

Methods:

The experiment was conducted in a birch forest just below the tree line surrounding Kilpisjärvi Biological Station, in the northwest corner of Finland, north of the Arctic Circle.

The five scenarios described previously were carried out as follows. Three trials were performed for each scenario, each one using a new piece of clothing:

- Abandoned Outdoor evidence: the clothing was placed at an outdoor location and left there for five days.
- Abandoned Indoor evidence: the clothing was placed at an indoor location within Kilpisjärvi Biological Station and left there for five days.
- Partially Buried: the clothing was partially buried and left that way for five days.
- Secondary Site evidence: the clothing was placed at one location for two days then moved (using gloves) to another location for three days. For one trial, the clothing started indoors and was moved outdoors, the other two trials had clothing that was moved from one outdoors location to another.
- Movement through Scene: the clothing was put on by Jose Suarez who then moved through an outdoor area for two and a half minutes. The evidence was then collected.

After the treatments, each piece of clothing was analyzed one-by-one using the adhesive tape method. A strip of tape was repeatedly stuck to and stripped off various parts of the clothing, folded onto itself to preserve what was collected, and then cut into small rectangular pieces which were analyzed using a compound light microscope. Any pollen grains found were recorded in video and/or photograph.

Results:

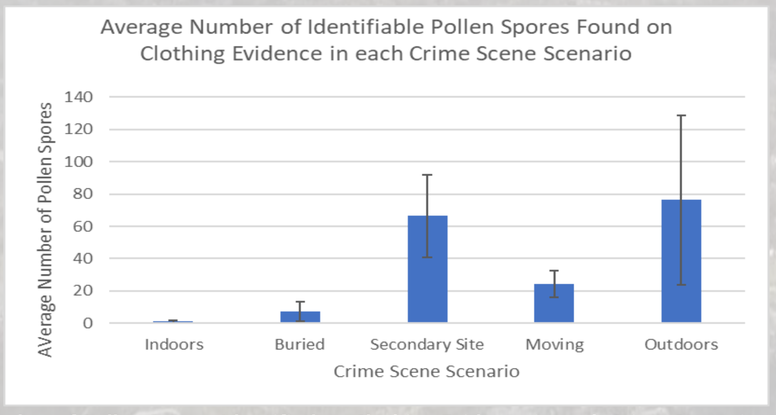

Figure 2: Average Number of Pollen Spores Identified on Clothing Evidence in each Crime Scenario – The above bar graph displays the average number of pollen spores that were identified amongst the three pieces of clothing evidence in each crime scene scenario. The error bars represent the calculated standard deviation for each scenario’s three trials.

As displayed in the above figure, secondary site evidence (evidence that was moved from one location to another) and outdoors evidence collected, on average, the greatest amount of usable pollen evidence, but they both also had the largest standard deviations implying a great amount of variability in the amount of pollen collected on individual clothing pieces in those scenarios. Moving evidence (evidence that was worn while subject moved through different areas) had the next highest amount of pollen on average, and it also had a lower standard deviation implying lower variability. Buried and Indoors evidence had trace amounts of pollen on average while also having the lowest variabilities.

In total, about 15-20 different plant species were identified from the pollen found on the evidence samples. It’s possible that the number should be higher as some pollen spores were obscured by dirt or other debris, and some pollen spores were found that we did not have a collected standard for and thus could not identify accurately. That said, while pollen amounts varied between scenarios, pollen composition remained fairly consistent, with similar plant species appearing on evidence from all scenarios regardless of specific location at Kilpisjärvi Biological Station.

Discussion:

Based on these results, the following conclusions were reached:

- Pollen is a viable source of forensic evidence in the Arctic, even before blooming season, though it is more useful in certain conditions
- Our hypothesis was mostly correct in that pollen evidence is not viable for indoor crime scenes and mostly viable in outdoor crime scenes, except in cases where evidence is buried where soil both shields the evidence from collecting pollen, and obscures any that is collected when viewing the sample under a microscope
- Evidence that is abandoned outdoors or moved between locations is more likely to contain large, usable amounts of pollen for forensic investigations, but evidence that is worn by someone at the scene is more likely to produce consistent results while the success of finding pollen on outdoors or secondary site evidence can vary greatly
- Identified pollen spores came from plant species native to the Arctic, suggesting pollen evidence can narrow down an environment evidence has passed through
- The wide differences in pollen compositions and amounts, even between clothing from the same crime scene scenarios, suggests pollen can narrow down a more specific location through which evidence has passed, but confirming this will require the calculation of pollen ratios which was not done in this experiment
- Some possible sources of error and limitations include: contamination of samples from improper packaging or handling with improper gloves, small sample sizes for both known and experimental samples, and vast differences in clothing size (i.e. socks vs. a pair of blue jeans) that might have allowed some samples to collect more pollen due to simply having more surface area with which to do so
- Future research might include: comparing the viability of pollen evidence in different ecosystems (i.e. the arctic vs the desert) or different times of the year, the formal calculations of pollen ratios to determine the ability of pollen to localize a piece of evidence, and studying if the use of dyes or electron microscopes makes it easier to identify and thus use pollen spores as evidence

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