Latent Fingerprints: A Preliminary Report

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This is an abridged text of a paper presented at the 71st Annual Educational Conference of the International Association for Identification, London Tara Hotel, Kensington, on 29 August 1986.

There is no scientific method for dating latent fingerprints and nothing in this paper should be construed as a viable dating technique. The purpose of this paper is merely to acquaint you with research am presently conducting in the hope of developing such a technique and, by so doing, to encourage others to perform research in this area.

To explain the premises underlying my research project in attempting to chemically date latent fingerprints, it is necessary to first present the sequence of events and observations that led me to research in this area.

BACKGROUND

In a previous paper [1], I gave a brief description of the naturally occurring fats and oils found in latent print residue, a class of substances known as lipids. That paper was a continuation of a previous paper on the chemical composition of sweat [2], and the purpose of both was to encourage research for new and improved latent fingerprint techniques. I had hoped the material would provide someone with a research idea.

I have been interested in the lipid material found in latent print residue as my view was, and remains, that it is a topic largely neglected by researchers in the fingerprint field. Texts and articles on latent fingerprints mention the lipid material only very generally as products of sebaceous origin and make no attempt to adequately describe the exact composition.

A 1974 report [3] shows the diversity and complexity of lipid material on human skin surfaces. Of particular interest in the report cited are tables 1 and 2, which show the percentage of each lipid component type in relation to the total amount of lipid material and give a break-down of the unesterified fatty acids. These fatty acids are not found in the sebaceous glands; they form on the skin surface by hydrolysis. Of the 21 fatty acids listed in table 2 of the cited reference, 14 are unsaturated.

It is my view that certain latent fingerprint techniques, such as iodine fuming, are dependent upon the double bonds of the unsaturated fatty acids, and that the iodine is absorbed by the fatty acids by the process of halogenation. in addition to the free fatty acids, the unsaturated fatty acids are also in the triglycerides and wax esters present. Although not specifically mentioned in my first article, the double bonds of also play a role in the iodine reaction. There are those who disagree with this view and who hold that the reaction is with water [4], or that the iodine addition to double bonds is colorless and the color of iodine-developed prints is simply due to absorption by the latent print residue [5].

The use of iodine fuming to visualize unsaturated compounds by reaction with the double bonds is too well established in scientific literature [6-9] as an accepted technique for visualizing such compounds to warrant further debate here. insofar as latent print development, the issue is immaterial. Our concern is whether the ridge details match those of a particular inked impression and not the chemical processes involved. The visualization of unsaturated lipids is important, from my viewpoint, in that it led to the premise that these lipids may hold the key for a dating technique for latent prints on nonporous surfaces.

To determine whether the iodine was reacting with the lipids or water in latent print residue, a latent print was deposited on a silica gel coated glass plate and the plate was placed in a desiccator at C for minutes to remove its water content. The plate was then subjected to iodine fumes and the resulting visualized print was photographed.

The iodine-developed print was then cleared with ammonia fumes and the plate treated with osmium tetroxide fumes. Osmium tetroxide is well known for its reaction with the double bonds of unsaturated compounds. The osmium tetroxide-developed print was photographed and compared to the photograph of the developed print. In intensity, shading, strength and clarity, both prints had about the same appearance. Undeniably water and other substances in latent print residue in which iodine is soluble or absorbed are important in the development of the print, but believe this test illustrates the major role of lipids in that development.

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glass plate were removed with petroleum ether and spotted on separate silica gel coated 2.5 x 10 cm glass thin-layer chromatography (TLC) plates. The lipids were resolved by using a solvent series of successive development in hexane (to 9 cm), benzene (to 9 cm), and finally a mixture of hexane:ether:acetic acid 70:30:1 (to 4cm) [10].

The resolved lipids on the first plate were then charred by spraying with 50-percent sulphuric acid and heating the plate to 220" C. A second plate was then visualized with iodine fuming. To preclude the possibility that the iodine was also being absorbed by saturated lipids, the plates were also sprayed with a l-percent solution of a-cyclodextrin in 30-percent ethanol, dried, placed in a humidity cabinet for one hour at room temperature, and then subjected to iodine fumes [18]. The resulting chromatograms did not differ significantly from those exposed only to iodine fumes. Although this procedure establishes that the iodine is reacting with unsaturated compounds, it does not identify them.

A chromatogram was then prepared to compare the extract from latent print residue with known standards of lipids using the same solvent series. The resulting chromatogram was visualized with iodine fumes. This test leaves little doubt regarding the types of lipids in latent print residue reacting with iodine. The first column is an extract from latent prints deposited on glass; 2, squalene; 3, cholesterol oleate (wax ester); 4, triolein (triglyceride); 5, cholesterol; and, 6, oleic acid (unsaturated fatty acid).

Numerous chromatograms were made and I noted that differences could be found in the visualization of extracts from fresh prints and those from prints that had been set aside for several weeks. It appeared that the free fatty acids, cholesterol and squalene were not present in the older prints.

To simulate aging and test this observation, latent prints were deposited on glass plates and placed in an oven at 90° C for periods ranging from 30 minutes to 4 hours. The latent residue was then extracted and a thin-layer chromatogram made using the same solvent series as previously mentioned. It was found that the lipids disappeared in the following sequence: free fatty acids, cholesterol, and squalene. This is possibly due to molecular weight, which is generally inversely proportional to vapor pressure. The triglycerides and wax esters continued to be present in all the samples tested.

ANALYTICAL TECHNIQUE

Thin-layer chromatography is not, however, the most suitable analytical technique for continuing research in this area. To obtain sufficient lipid material for making the chromatograms thus far cited, numerous prints had to be deposited on each glass plate used for collecting the prints. Regardless of the results that may be obtained, no dating technique would be practical unless a single latent print could be analyzed. The initial problem is, then, the development of an adequate analytical technique even one problem encountered was the flow of men and materials down the Ho Chi Minh Trail in Laos and Cambodia. The trail could be bombed and strafed with aircraft, but this was ineffective unless the enemy was actually on the trail at the location pinpointed. The United States Army conducted considerable research to develop an apparatus that could detect enemy troops on the trail.

Sound and motion detectors were not practical as animals and weather could both give false alarms. What was needed was a remote detection apparatus that would unfailingly detect only human beings. Taking a cue from an existing bio-sensory device (bloodhounds), which has shown a remarkable ability to detect human beings by the chemical signature of their spoors, extensive resarch was directed towards detecting human beings by their body odors, or smell.

All types of natural human exudates were examined as well as methods for detecting them in their vaporous form. All of the research was initially classified security information, but some of it has been declassified in the last ten years [11- 16]. Much of the analytical instrumental techniques has been outdated, but this material provides a start for developing an analytical technique for examining the residue of a single latent fingerprint. It almost seems unnecessary to point out that there is abundantly more material available for analysis in the residue of a latent print than can be found in odors.

Studying the Department of Defense research available and correlating it to my proposed research, it appears that the best analytical technique will be either gas chromatography or high pressure liquid chromatography. A sample of latent print residue was run on a Hewlett-Packard 5992V Gas Chromatograph/ Mass Spectrometer. Squalene, cholesterol, behenic acid, lauric acid, myristic acid, palmitic acid and stearic acid were identified at this time, but not the heavier wax esters and triglycerides as high temperature columns were needed.

Since then the KBI has purchased a Hewlett-Packard 5890 Gas Chromatograph with 5970B Series Mass Selective Detector and software. An initial preliminary analysis of latent print residue for lipids was run on this instrument, but again we need a high temperature column for satisfactory results.

The research is presently at a standstill until we obtain the high temperature columns. I believe that within the next year or two we may be able to form a conclusion as to whether or not it may be possible to develop a dating technique for latent fingerprints on nonporous surfaces. If such a techniuqe is possible, many factors will have to be taken into consideration and properly noted at the time the prints are collected as both temperature and humidity will both have an influence on the presence or absence of the lipids.

I must also stress that we are an operational crime laboratory and our priority is case work. All our research

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must be on a time and equipment available basis. If any of you find this line of inquiry of interest, please feel free to conduct your own research and you can depend upon us for all the assistance we can provide.

ADDENDUM

Subsequent to the presentation of this paper, the author has learned of research in dating latent prints using high performance liquid chromatography (HPLC) by a team in Calcutta, India. Anyone interested in this area of research should also read "Aging Studies on Fingerprint Residues Using Thin-Layer and High Performance Liquid Chromatography", by Y. S. Dikshitulu, Lala Prasad, J.N. Pal and C. V.N. Rae, **Forensic Science International,** volume 31 (1986), pages **261-266.**

NOTE

The illustrations that accompanied the original paper have been deleted from this article as it is the author's view that they will not reproduce well in the printed media. If, however, anyone wishes a copy of the illustrations. they may contact the author.

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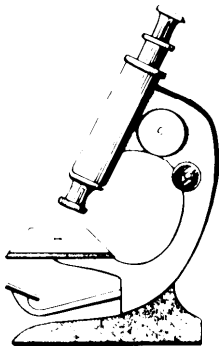

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