The Disappearing Fingerprints

by Deborah Noble

To be useful to the police, the latent fingerprints that may be left at the scene of a crime must be made visible. Today, more than 40 fingerprint development methods are available, although police generally still use the simplest methods—conventional dusting powder, ninhydrin, iodine fuming, and superglue fuming, with occasional help from alternative light sources (see box on p. 12). Sometimes, however, what the police don't find at the scene of a crime can tell more than what's there, according to Arthur Bohanan, senior criminologist with the Knoxville, Tennessee, police department.

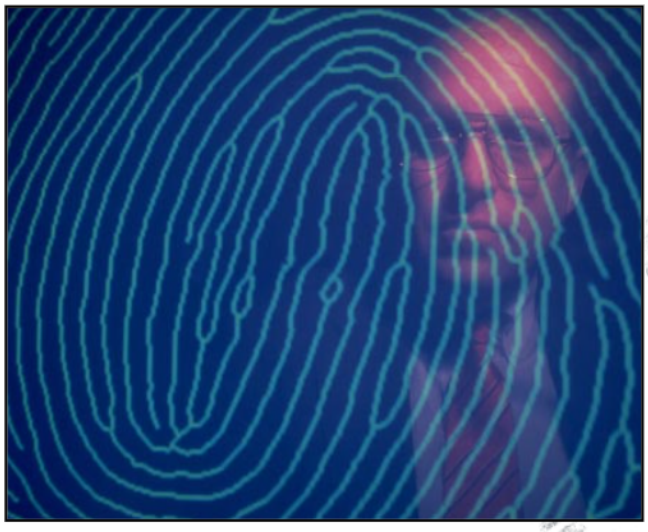


PHOTO BY ED KASHI, PHOTOTAKE

A San Francisco police officer positions a computer cursor at the distinctive line ends and junctions of a fingerprint. The computer will search its records for a similar pattern, then present the officer with the best matches.

Consider this case in point: One day in April 1993, an 8-year-old girl was kidnapped by a man who broke into her parents' house in the early morning hours. She was driven away in a green car, which she later described to the Knoxville police. According to criminologist Bohanan, "We later found out that [the kidnapper] had worked for the landlord as a handyman and had made a copy of the house key. He actually let himself into the house." The girl managed to escape from her attacker and made her way to a house nearby. There an elderly woman let her in and took her to the hospital, where the girl managed to describe the kidnapper's car to police. The police recovered the car after 4 days, arrested its owner, and began their crime scene investigation. And that's where they ran into trouble, says Bohanan.

The girl's detailed description indicated that she *must* have been inside the green car. Yet when the police team dusted the back seat, inside walls, and windows, none of her fingerprints appeared. They tried fuming the inside of the car with superglue, but nothing worked. Eventually, the police were able to link the girl to the car and its owner by matching fibers found in the car with those from the girl's nightgown. A year and a half later, the man was convicted.

However, Bohanan continued to be haunted by the girl's missing fingerprints. In a long career as a fingerprint expert, he had seen a few other cases where children's fingerprints went missing, but the investigators had always written it off as a fluke and gone on to work with other evidence. This time, he says, "I started thinking, maybe her fingerprints just weren't lasting very long." Between the initial investigation and the trial, Bohanan had to find a convincing explanation for the disappearance of the prints or, despite the other evidence, the defense would have a strong argument on their side—the absence of fingerprints in the car could cast doubt on the girl's story in court.

PHOTO BY RICHARD PASLEY, STOCK BOSTON, INC.

In this crime, a burglar forced open a sliding door and left fingerprints on the glass. It is important that the delicate, oily deposits be visualized as soon as possible. Here, the crime technician is using a soft brush to apply fine graphite powder to the latent print. He will apply, then remove, adhesive transparent tape, which will permanently record the pattern of the black powder.

Latent Prints

What had happened? A latent fingerprint is a thin deposit of oil. It can last for days, weeks, or months, depending on the surface it contacts and the environmental conditions. Latent prints are more likely to smear, fade, or wash away on nonporous surfaces such as glass, metal, and car paint, but they can usually be found for at least a few days, even in hot or humid weather. Some latent fingerprints more than 20 years old have been found in the pages of books, protected from light and air and trapped in the pores of the paper. In this case, though, the team failed to find any prints that might have come from the girl. It occurred to Bohanan that most of what is known about fingerprints comes from adults, and maybe children's prints are different somehow.

"A month after we recovered the car, we still had it in the pound," Bohanan recalls. "I sat my little grandnephew in it and had him put his hands all over the inside. I wanted to see how long we could detect his fingerprints." Bohanan found the fingerprints easily if he dusted for them within a few hours, but if he waited a day, it was as if the boy had never been there.

This rough test turned out to be extremely valuable and was useful much sooner than expected. That July, Bohanan was called in on a gruesome case, in which a toddler had been kidnapped, brutally murdered, and left in the bushes by her killer. With the earlier case and his new findings fresh in his mind, Bohanan says, "I jumped on this one. Usually investigators look at other things first, but when we recovered the car within 7 hours, I knew we didn't have much time. We started with the toddler's fingerprints, so we might find them before they disappeared." Bohanan's strategy paid off. "The feeling I got in that car as we were fingerprinting just chilled me to the bone. We found her little palm prints on the back window where she tried to push her way out of the car—she knew something bad was going to happen."

Bohanan decided to take his discovery a step further. The local Coca-Cola bottling company donated some cases of clean glass and plastic bottles. Over the next year, Bohanan had young children touch half the bottles in each case and adults touch the other half; then he measured how long it took the fingerprints to become undetectable on the nonporous surfaces. He stored some of the cases in his basement, which was fairly cool and dry, and some he carried around in the back of his police cruiser, in all kinds of weather and in all seasons. The bottles in the cruiser, he points out, were a good simulation of the natural conditions inside a kidnapper's car. Time after time, the children's fingerprints lasted only one-fourth as long as adults' and usually disappeared within 24 hours. He had his proof, but no explanation.

Bohanan asked experts at the FBI, Scotland Yard, Interpol, and even in the former Soviet Union, if they knew why children's fingerprints disappeared more quickly than adults', but none of them had considered the possibility of a difference. However, the director of the nearby Oak Ridge National Laboratory (ORNL) invited Bohanan up to meet some of the lab's top scientists, including Dr. Michelle Buchanan, the chemist whose laboratory would reveal what was causing kids' fingerprints to fade.

Lightweight molecules

Buchanan recalls, "It sounded like the compounds in children's fingerprints might simply be evaporating faster than adults'." Not much was known about the chemical compounds in latent fingerprints, she adds. The residue that is deposited by fin-

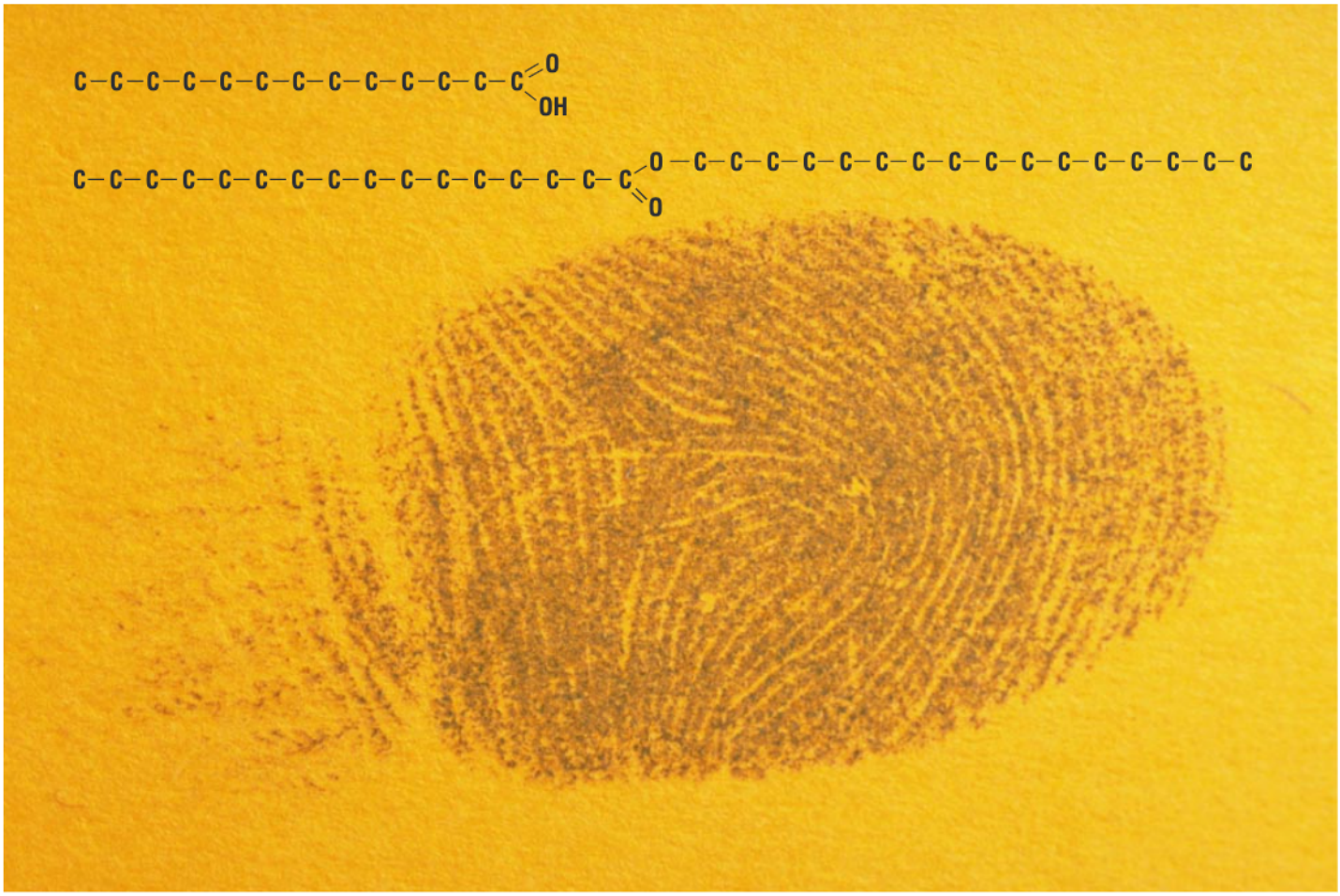
gers is about 99 percent water. The other 1 percent contains oils and fatty acids, esters, salts, urea, and amino acids. Because the amount of material left behind in a single latent print is so tiny to begin with—just a few microliters—the final amount of any one of these compounds is extremely small and very hard to analyze.

Buchanan and her colleague Keiji Asano, assisted by college students working in the laboratory, gathered fingerprint oil from some 50 volunteers who ranged in age from 4 to 46 years. Each volunteer was given a small vial of rubbing alcohol and directed to remove the cap, hold the vial between forefinger and thumb, and press the thumb over the mouth of the vial to keep it closed. As the vial was shaken up and down vigorously, the alcohol dissolved the natural oils from the thumb. When the vial was capped, the researchers had a sample that contained more fingerprint oil than they could obtain from a single latent print.

In Buchanan's laboratory, the investigators analyzed the samples by gas chromatography/mass spectrometry (GC/MS), a sensitive two-step technique. Each fingerprint sample was injected into the GC column and heated to gas phase; its chemical compounds were separated from each other as they passed through a long, narrow tube. (The chemical characteristics of each compound, such as polarity and size, determine how rapidly the compound moves through the tube.) As each purified compound emerged from the GC tube, the molecules were given an electrical charge; some broke into fragments. The resulting mixture of whole and fragmented molecules was divided into groups of equal mass and counted by the mass spectrometer. Because each compound breaks into distinctive fragments, a computer can match the MS data with similar data from known chemicals. The computerized database identified the different compounds in each fingerprint.

Once the compounds in each fingerprint were identified, the reason for the rapid disappearance of child fingerprints became clear. With GC/MS, Buchanan says, it was very easy to see the chemical differences between children's and adult's prints. "You could just look at the pattern for each fingerprint and say, 'This is a child' or 'This is an adult.'" Fingerprint samples from adults and older adolescents contained heavy oils and long fatty acid chains linked together with esters, but children's samples contained mostly unesterified and shorter fatty acid chains that were lighter and more likely to evaporate quickly (see figure).

"We saw that the heavier oils in adult and adolescent fingerprints were basically sebaceous," explains Buchanan. "Almost

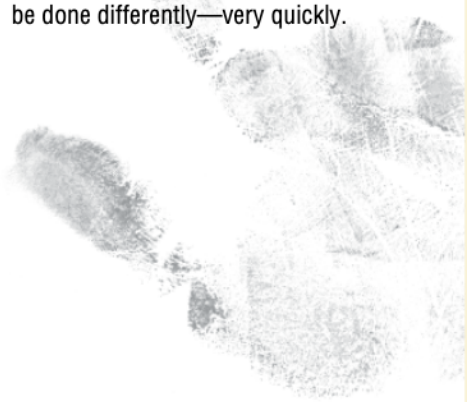


A fingerprint contains oils, fatty acids, amino acids, cholesterol, and other biomolecules—a mixture that varies from person to person. The fingerprints of children contain more fatty acids of low molecular weight (top), which evaporate in hours. The larger, heavier molecules found in adult fingerprints (bottom) last far longer. The sebaceous glands in your face begin producing the heavier molecules when you reach puberty. Some of these waxy chemicals are transferred to your fingers each time you touch your face. (For clarity, this illustration omits the hydrogen atoms that are attached to carbon atoms.)

PHOTO BY MARK C. BURNETT, STOCK BOSTON, INC.

everyone touches their forehead or their face, and these heavy oils stick to the fingertips. Before puberty, children's faces don't produce nearly as much sebum as teenagers' and adults', so their fingerprints have far less of these compounds." The children's prints also contained large amounts of cholesterol, which isn't particularly volatile but doesn't react with most of the fingerprint development reagents in use today (see box).

These experiments showed why kids' fingerprints can't be detected after 24 hours: Most of the compounds in them that can be developed with today's reagents—the oils—are light and volatile. Buchanan is continuing her research into children's fingerprints in hopes of developing a new technique for imaging children's prints beyond 24 hours. In the meantime, her work has made it clear that, in cases involving children, crime scene investigation must be done differently—very quickly.



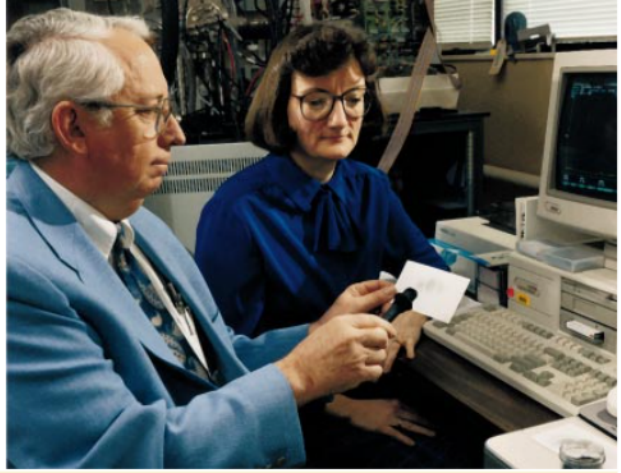
Deborah Noble is a science writer living in Columbia, MD. This is her first article for *Chem Matters*.

FOR FURTHER INFORMATION

Clark, Steve; Quigley, Michael N.; Tezak, James. "Chemical detection of latent fingerprints." *Journal of Chemical Education* **1993**, *70*(7), 593.

Kurland, Michael. *How to Solve a Murder: The Forensic Handbook*. Macmillian: New York, 1995.

Noble, Deborah. "Vanished into thin air: The search for children's fingerprints." *Analytical Chemistry* **1995**, *67*(13), 435.



Art Bohanan demonstrates fingerprint visualization by conventional black powder dusting in Michelle Buchanan's lab. On the computer monitor is a chromatogram for cholesterol, one of the chemical components of fingerprint residues in both adults and children.

ORNL PHOTO BY CURTIS BOLES

Developing Latent Fingerprints

When a finger touches a surface, it may leave an invisible pattern of oil called a latent fingerprint. Investigators must develop it into a visible print that can be photographed.

Dusting powder

The traditional method. Fine powder (usually carbon black) is brushed onto nonporous surfaces, sticks to very fresh (less than 3 hours old) latent prints. New fluorescent powders can make a print stand out against a visually confusing background (newsprint, colored surfaces, etc.).

Silver nitrate solution

Reacts with the salt in sweat to form silver chloride (a white precipitate). Rarely used today.

Iodine

When heated, iodine fumes react reversibly with the carbon–carbon double bonds in fats and oils for temporary visualization (with new stabilizing reagent sprays, staining can last up to 2 days). Good for spraying on porous objects like cardboard that have absorbed the fingerprint residue.

Ninhydrin

When sprayed on a latent print, ninhydrin reacts with the nitrogen in amino acids and proteins and turns purple after heating. This method works well on papers and other porous surfaces; it can detect 1 microgram of amino acids, about the amount in a fingerprint.

Alternative light sources

Argon lasers, infrared (IR), and ultraviolet (UV) lamps can visualize fingerprints with no chemical reagents. Fingerprints contain compounds that fluoresce under UV light. With laser dyes such as Rhodamine 6G, a fingerprint can be photographed under alternative light sources while the background disappears.

Cyanoacrylate (superglue) fuming

Superglue is heated to the fuming point, condenses on an object, and reacts with moisture to coat the latent fingerprints with a thin protective plastic layer of cured glue that can be lifted with transparent tape.