Next in Forensics: Bacterial 'Fingerprints'

A new discovery may someday help forensic scientists identify suspects' personal bacterial "signatures" left at crime scenes

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While its widespread application in law enforcement is still years away, scientists at the University of Colorado, Boulder have developed a technique that can match the “personal” bacteria on an individual’s hands and fingers with bacteria deposited on computer keyboards and mice. Once perfected, the process eventually could become another tool in the forensics arsenal, along with fingerprint and DNA analysis.

“It could be used as part of a line of evidence, and there even may be situations where it might work better than standard fingerprinting,” said Noah Fierer, an assistant professor in the department of ecology and evolutionary biology. “There are a lot of circumstances where you can’t get clear fingerprints.”

All individuals carry bacteria on their bodies, the vast majority of it harmless. On average, any two people share only about 13 percent of their bacterial species, which also can vary in quantity, Fierer said. “We really are pretty distinct.” Moreover, everyone “leaves a unique trail of bugs behind as we travel through our daily lives,” he said.

“People are so distinct, and that was the impetus for our study: Can you take advantage of that distinctiveness?” he added. “The next question is: why are people so different? We don’t know. It could be related to any number of things: our physiology, the environment, diet, or all of the above.”

The team used powerful gene sequencing techniques to conduct the analyses. The researchers swabbed bacterial DNA from all of the individual keys on three personal computers and also swabbed all ten fingers of the keyboard owners, comparing the results to swabs taken from other keyboards never touched by the subjects. The bacterial DNA from the keys matched much more closely to bacteria of keyboard owners than to bacterial samples taken from random fingertips and from other keyboards.

The process involved examining a specific bacterial gene from each sample. The gene, called the 16S ribosomal RNA gene, is a useful tool for identifying bacterial species. All cells carry a 16S gene, but the gene changes just enough over time to distinguish one species from another. Each bacterial sample is capable of generating a unique “signature” of all the bacteria that are present. Comparing those signatures, which derived from algorithms developed by Rob Knight, another member of the team, can identify two microbial communities as being closely related. In this case, the 16S profiles from the fingers of the keyboard users closely matched the 16S profiles from each user’s keyboard.

Put another way, the CU-Boulder team used a “metagenomic” survey to simultaneously analyze all of the bacteria on the fingers, palms and computer equipment, Knight said. The effort involved isolating and amplifying tiny bits of microbial DNA, then building complementary DNA strands with a high-powered sequencing machine that allowed the team to identify different families, genera and species of bacteria from the sample.

“This is something we couldn’t have done even two years ago,” Fierer said. “Right now we can sequence bacterial DNA from 450 samples at once, and we think the number will be up to 1,000 by next year. And, as the cost of the technology continues to drop, even smaller labs could undertake these types of projects.”

In a second test, the researchers swabbed nine keyboard mice that had not been touched in more than 12 hours and collected palm bacteria from the mouse owners. The team compared the similarity between the owner’s palm bacteria and owner’s mouse with 270 randomly selected bacterial samples from palms that had never touched the mouse. In all nine cases, the bacterial community on each mouse was much more similar to the owner’s hand.

Knight said when the team began its study, he expected the computer devices to carry one distinct community of bacteria, while a person’s hands would support a different community. “You’d think the conditions for bacterial survival on a keyboard--a hard, dry surface--would differ enough from the conditions on the skin that the bacteria would differ,” he said.

But “if you are a bacterium trying to live on skin surface, you’ve got to be pretty tough, since you’re exposed to many things,” Fierer said. “If you’re a weak sort of fragile thing, you’re not going to make it on skin. So it makes sense that these bugs can hack it on these surfaces.”

The new technique may prove especially valuable to forensic experts because, unless there is blood, tissue, semen or saliva on an object, it’s often difficult to obtain sufficient human DNA for forensic identification, Fierer said. But, since there are plenty of bacterial cells on the skin surface, it may be easier to recover bacterial DNA than human DNA from touched surfaces, the scientists said.

To be sure, glove-wearing could eliminate the opportunity, as it does with finger-printing. But hand-washing might not. “You do remove a lot of bacteria when you wash, but your native community comes back pretty quickly, within hours,” Fierer said.

Additional research must be conducted on how human bacterial signatures adhere to different surfaces like metal, plastic and glass, Fierer said. But the new process could help match objects to users in cases where clear fingerprints cannot be obtained – from smudged surfaces, fabrics and highly textured materials, he said. The new technique would even be useful for identifying objects touched by identical twins, since they share identical DNA but they have different bacterial communities on their hands.

The study showed the new technique to be 70 to 90 percent accurate, a percentage that likely will rise as the technology becomes more sophisticated, Fierer said.

Many questions--legal, ethical and scientific--remain. “While there are legal restrictions on the use of DNA and fingerprints, which are ‘personally-identifying,’ there currently are no restrictions on the use of human-associated bacteria to identify individuals,” Fierer said. “This is an issue we think needs to be considered.”

Moreover, “This is just proof of concept,” Fierer said. “There is still a lot of work we need to do. We need to figure out the limitations: where it works, where it doesn’t. It could take years before it’s ready for prime time.”

In addition to Fierer and Knight, who is an assistant professor of chemistry and biochemistry, the team included Christian Lauber and Nick Zhou, of CU-Boulder’s Cooperative Institute for Research in Environmental Sciences; Daniel McDonald of CU-Boulder’s department of chemistry and biochemistry; and Elizabeth Costello, a Stanford University postdoctoral researcher.

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