New hand bacteria study holds promise for forensics identification

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A new technique developed at CU-Boulder to identify individuals by the unique communities of hand bacteria they leave behind on objects they have handled may prove to be a valuable forensic tool in the future. Credit: Steve Miller, CIRES

Forensic scientists may soon have a valuable new item in their toolkits -- a way to identify individuals using unique, telltale types of hand bacteria left behind on objects like keyboards and computer mice, says a new University of Colorado at Boulder study.

The CU-Boulder study showed that "personal" bacterial communities living on the fingers and palms of individual computer users that were deposited on keyboards and mice matched the bacterial DNA signatures of users much more closely than those of random people. While the development of the technique is continuing, it could provide a way for forensics experts to independently confirm the accuracy of DNA and fingerprint analyses, says CU-Boulder Assistant Professor Noah Fierer, chief author on the study.

"Each one of us leaves a unique trail of bugs behind as we travel through our daily lives," said Fierer, an assistant professor in CU-Boulder's ecology and evolutionary biology department. "While this project is still in it's preliminary stages, we think the technique could eventually become a valuable new item in the toolbox of forensic scientists."

The study was published March 15 in the Proceedings of the National Academy of Sciences. Co-authors on the PNAS study included Christian Lauber and Nick Zhou of CU-Boulder's Cooperative Institute for Research in Environmental Sciences, or CIRES, Daniel McDonald of CU-Boulder's department of chemistry and biochemistry, Stanford University Postdoctoral Researcher Elizabeth Costello and CU-Boulder chemistry and biochemistry Assistant Professor Rob Knight.

Using powerful gene-sequencing techniques, the team swabbed bacterial DNA from individual keys on three personal computers and matched them up to bacteria on the fingertips of 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, Fierer said.

In a second test, the team 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.

The team sampled private and public computers at CU-Boulder, as well as hand bacteria collected from a variety of volunteers on campus. The study showed the new technique is about 70 to 90 percent accurate, a percentage that likely will rise as the technology becomes more sophisticated, said Fierer, who also is a CIRES fellow.

In an effort to see how persistent the bacteria colonies were, the team also swabbed the skin surfaces of two individuals, freezing one set of samples at minus 4 degrees Fahrenheit and leaving the other room temperature. The results showed room-temperature bacterial colonies remained essentially unchanged after two weeks, pointing up the technique's potential as a forensic tool. "That finding was a real surprise to us," said Fierer. "We didn't know just how hearty these creatures were."

Previous research by Fierer and his colleagues -- which indicated a typical hand carries about 150 bacterial species -- also showed only 13 percent of bacteria species found a single hand were shared by any two people. "The obvious question then was whether we could identify objects that have been touched by particular individuals," Fierer said.

The CU-Boulder team used a "metagenomic" survey to simultaneously analyze all of the bacteria on the fingers, palms and computer equipment, said Knight. 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," said Fierer. "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."

Another reason the new technique may prove valuable to forensic experts is that unless there is blood, tissue, semen or saliva on an object, it's often difficult to obtain sufficient human DNA for forensic identification, said Fierer. But given the abundance of bacterial cells on the skin surface, it may be easier to recover bacterial DNA than human DNA from touched surfaces, they said. "Our technique could provide another independent line of evidence."

More research needs to done on how human bacterial signatures adhere to different surfaces like metal, plastic and glass, said Fierer. But the new technique may be useful for linking 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 new PNAS study was funded by the National Science Foundation, the National Institutes of Health, the Crohn's and Colitis Foundation of America and the Howard Hughes Medical Institute.

"This project is one example of why I got into science," said Fierer. "We go down a lot of different paths trying to answer research questions we have, some of which pan out and some that don't. This particular project is exciting for the whole team."

Fierer said the new technique brings up bioethical issues to consider, including privacy. "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," he said. "This is an issue we think needs to be considered."

In a related November 2009 CU study led by Knight, the team developed the first atlas of microbial diversity across the human body, charting wide variations in microbe populations from the forehead and feet to noses and navels of individuals. One goal of the human bacterial atlas project is to find out what is normal to healthy people to provide a baseline for studies looking at human disease states, said Knight.

Working with a $1.1 million NIH grant to develop new computational tools to better understand the composition and dynamics of microbial communities, Knight and his colleagues have been developing novel methods to tag DNA samples with error-correcting "barcodes" to obtain more accurate gene sequencing data.

In the 2008 hand bacteria study, the researchers detected and identified more than 4,700 different bacteria species across 102 human hands in the study, only five species of which were shared among all 51 participants. The study also showed that the diversity of bacteria on individual hands was not significantly affected by regular hand washing.

Provided by University of Colorado at Boulder