falls. As the nation's only Innocence Project director who's also a scientist, "he's absolutely essential to what we do," said Aimee Maxwell, executive director of the Georgia Innocence Project in Decatur, which Hampikian helped establish.

In Tapp's case, Hampikian has pushed for the use of a new, controversial DNA technique that he believes may yet identify the real killer and exonerate Tapp. In other instances, such as the notorious Amanda Knox conviction in Italy, he has shown how DNA evidence was false or misconstrued. "Just because it's DNA doesn't mean it's good science," he says.

HAMPIKIAN, 54, who looks a bit like the comedian Bill Maher, is affable, funny, and likes aphorisms. On science and religion: "Theologians are willing to die for their beliefs but scientists are willing to let their beliefs die."

His involvement with forensic science was a multiyear courtship. He had done research on the Y chromosome in Australia and was teaching at Clayton State University in Morrow, Georgia, in 1993 when an associate of famed criminologist Henry Lee asked him whether science could determine the sex of a person based on traces of saliva left at a crime scene. (It could.) Later, he was so captivated by the story of Calvin Johnson, who was exonerated by DNA in 1999 after spending 16 years in prison for rape, that he helped Johnson write an autobiography, *Exit to Freedom*. "The idea that you could free someone with a little bit of this snotlike stuff was a notion that seemed thrilling to me," he says.

Hampikian joined the original board of the Georgia Innocence Project, launched in 2002. In 2004, he moved to BSU, where, in addition to teaching and doing research in genetics, he helped found the Idaho Innocence Project. He used DNA to help exonerate at least a dozen wrongfully convicted people in the United States, Taiwan, and Italy. He's had losses as well. Four of his clients were eventually executed.

DNA evidence is so powerful because it has firm roots in science and is backed by statistics. Analysts focus on 13 or more places in the genome, called loci, where humans are extraordinarily diverse. Each locus contains a "short tandem repeat," a bit of DNA that is repeated multiple times. The exact number of repeats at each locus varies from person to person and can range anywhere between the low single digits to the mid-50s. Because we get one copy of each chromosome from our mother and one from our father, there are two numbers of repeats for each locus, which appear as peaks on an electropherogram, a chart produced by a genetic analyzer.

The chance that two people have the same pairs at all 13 loci is astronomically low. It's a bit like pulling the handles of two slot machines with 13 cylinders each—all containing dozens of symbols—and hoping they match up right down the line. To reduce the risk of false matches even further, the Federal Bureau of Investigation (FBI) will soon release new guidelines calling for DNA forensics to use 20 or more locations.

Its accuracy has made DNA evidence virtually unassailable. A landmark report published by the National Research Council in 2009 dismissed most forensics as unproven folk-wisdom but singled out DNA as the one forensic science worthy of the name. Yet in recent years Hampikian and other geneticists have begun to question the technology. Thanks to a series of advances—including the polymerase chain reaction, which can multiply tiny amounts of DNA—it's now possible to detect DNA at levels thousands of times lower than when DNA fingerprinting was developed in the 1980s. Investigators can even collect "touch DNA" from fingerprints on. A mere 25 or 30 cells will sometimes suffice.

This heightened sensitivity can easily create false positives. Analysts are picking up DNA transferred from one person to another by way of an object that both of them have touched, or from one piece of evidence to another by crime scene investigators, lab techs—or when two items jostled against each other in an evidence bag.

That was the case with Amanda Knox, a U.S. student accused of stabbing her U.K. housemate Meredith Kercher to death in Perugia, Italy. Authorities had accused a local young man named Rudy Guede of sexually assaulting and killing Kercher. The evidence against him was overwhelming—palm prints, fingerprints, and his DNA on the victim and throughout her room—and he was eventually found guilty. But Italian prosecutors also charged Knox and her boyfriend Raffaele Sollecito with murder. Traces of Sollecito's DNA had been found on the clasp of a bra belonging to Kercher, suggesting that he had taken part in the sexual assault, while a knife in Sollecito's kitchen drawer showed

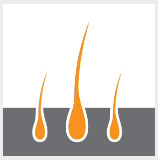
FORENSIC FRONTIERS

How hair can reveal a history

By **Hanae Armitage** *and* **Nala Rogers**

Forensic hair analysis has developed a bad reputation. The technique has relied on traits such as color, thickness, and curvature to link a suspect to a crime scene. But an ongoing reanalysis of old cases by the U.S. Justice Department found that analysts have often overstated their case in the courtroom; several people convicted based on a hair sample were later found to be innocent.

Now, sophisticated analytical techniques are giving hair a new role in forensics. The goal is no longer matching a suspect to a crime scene but using hair to infer physical characteristics or even the travel history of an unknown criminal or victim. Most hairs found at crime scenes don't have enough DNA in them for analysis; "doing a chemical analysis and trying to determine some trait about the individual … is really the only alternative," says Glen Jackson, a forensic scientist at West Virginia University in Morgantown.



Keratin, the main component of human scalp hair, contains all 21 amino acids, but the ratios depend on the body's biochemistry and differ from person to person. Hydrolyzing the amino acids and measuring their quantities yields a profile that, when compared with a database, gives an indication of a person's sex, age, body mass index, and region of origin, Jackson says—although the accuracy varies by trait and more work is needed.

The ratios of isotopes—atoms of the same element that differ in the number of neutrons—in hair can also yield clues. The ratios of hydrogen and oxygen isotopes in drinking water vary from region to region and are captured in hair. As a result, isotopic analysis of hair can provide clues about where a person has been in the previous months—or years, if the hair is long enough. In 2008, a Utah company called Isoforensics discovered that "Saltair Sally," an unidentified woman found dead in Utah in 2000, had repeatedly moved between the Pacific Northwest and the Salt Lake City area before she died—a clue that helped identify her in 2012. "People are coming to us and saying 'Hey, I heard about this technique and I've got a cold case from 1976. Do you think it will help?'" says Isoforensics President Lesley Chesson. ■

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