FORENSIC SCIENCE

Phylogenetic Analysis: Getting Its Day in Court

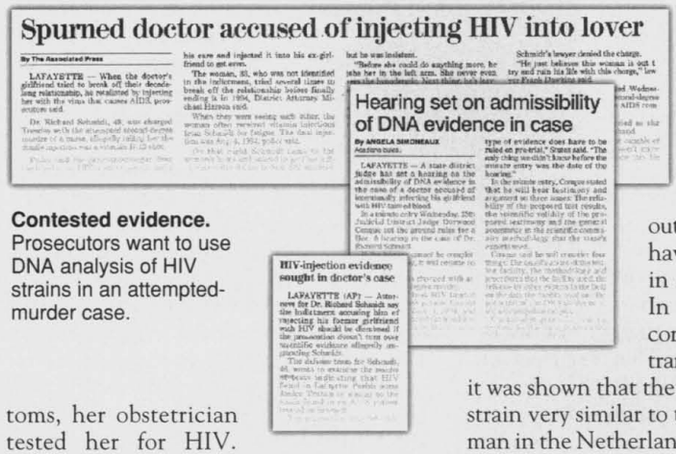
Blood often figures prominently in trials for attempted murder—but not usually as the weapon. Later this spring, however, prosecutors in Lafayette, Louisiana, will attempt to prove that Richard J. Schmidt, a gastroenterologist in that city, tried to kill his former lover by injecting her with HIV-infected blood from one of his patients.

The alleged use of blood as a weapon may not be the only unusual feature of the trial. As part of his case, the district attorney wants to introduce a type of DNA analysis never before used in a criminal trial in the United States: phylogenetic analysis, a technique that compares DNA samples from various sources—different HIV isolates in this case—to see how closely they are related. The prosecution hopes to show that the virus infecting Schmidt's accuser, Janice Trahan Roberts, is most likely to have come from one of the physician's patients. Schmidt's lawyers have challenged the admissibility of the phylogenetic analysis, however, arguing that the technique is inherently more uncertain than DNA fingerprinting, which is widely accepted in the courts as a means of matching DNA samples. They also argue that in this case, the controls used and the laboratory work are seriously flawed.

The defense lost the first round. In January, after 4 days of testimony, Louisiana District Judge Durwood Conque ruled that the technique is indeed valid and reliable science, and that it could be used properly in this case. But on 3 March, the defense filed an appeal, a move that may delay the trial, currently scheduled for 12 May, until Louisiana's third circuit court can rule on Conque's decision—perhaps not for several months.

More than just Schmidt's innocence or guilt may hang on the outcome. His case is a testing ground for a molecular technique that is likely to find plenty of forensic applications in the future, says Gerald Myers, an expert on HIV strains at Los Alamos National Laboratory in New Mexico. AIDS "has been called the most litigated disease in American history," he says. In addition, phylogenetic analysis may eventually be used to trace other infectious agents—in cases of food poisoning or even biological warfare. "The horse is out of the barn," Myers says. "[This technology] is here, and cases like this are going to continue to happen."

The current case began in August 1994, when Trahan, who had been having a 10-year affair with Schmidt, allegedly tried to end their relationship. On the night of 4 August, Trahan says, Schmidt, who had been giving her vitamin shots, came to her house and gave her another injection against her wishes. In December, after Trahan began having suspicious symptoms, her obstetrician tested her for HIV. Trahan found out she carried the virus in January 1995, and in May of that year, she accused Schmidt of deliberately infecting her. Schmidt has pleaded not guilty, and his lawyers say he was at home with his wife on the night in question.



Contested evidence. Prosecutors want to use DNA analysis of HIV strains in an attempted-murder case.

As part of their investigation, the police obtained samples of blood from Trahan and from Schmidt's only HIV-positive patient. They arranged to have Michael Metzger, then a graduate student in the lab of molecular biologist Richard Gibbs at Baylor College of Medicine in Houston, compare DNAs from those two HIV strains to each other. They were also compared to viral sequences from 30 randomly chosen HIV patients in the Lafayette area and to hundreds of HIV sequences in the national database.

To be admitted in court, a scientific technique must—at minimum—be generally accepted in the scientific community, must "rise to a threshold of reliability," and its value must outweigh the danger of unfairly prejudicing or confusing the jury. Traditional DNA fingerprinting, which is now widely accepted by the U.S. legal system, relies on the fact that each individual, with the exception of identical twins, has a unique DNA pattern and looks for an exact match between a source and a sample from a crime scene or victim. In contrast, phylogenetic analysis looks at different organisms or strains. By comparing the sequences of corresponding DNA stretches and taking into account how quickly mutations occur (about 1 million times faster in HIV than in humans), researchers can tell how closely related different organisms or strains of virus are.

One notable example of that application came 5 years ago when the Centers for Disease Control and Prevention (CDC) in Atlanta used phylogenetic analysis to show that a Florida dentist was the probable source of HIV infections in as many as six of his patients. That evidence never made it to trial, because the civil case a patient had brought against the dentist's insurer was settled out of court (*Science*, 24 January 1992, p. 392; and 22 May 1992, p. 130). At least two courts outside the United States have used such evidence in recent years, however. In Sweden, a rapist was convicted of deliberate transmission of HIV when it was shown that the victim carried an HIV strain very similar to the defendant's. And a man in the Netherlands was jailed for injecting his ex-girlfriend with blood from an HIV-infected drug user.

The two scientists hired by the defense agree that the science of phylogenetic analysis is generally accepted within the scientific community. But one of them, virologist William Gallaher of Louisiana State University Medical Center in New Orleans, says it could easily confuse a jury: "You're using something that is inherently more uncertain [than DNA fingerprinting], and you're piggybacking it on the DNA evidence that has an excellent reputation." Two strains can look closely related, he says, even if they did not arise from direct transmission. Another defense expert, molecular virologist James Mullins of the University of Washington Medical School, who helped the CDC in its investigation in Florida, says the application of the technique in this case is flawed. Without extensive evidence ruling out other plausible routes of infection, he says, the phylogenetic analysis cannot stand on its own.

Both scientists also question the quality of the laboratory work done. They note that Metzger's initial report failed to acknowledge that during the analysis, two of the control samples became contaminated with a laboratory strain of HIV. David Hillis, a

molecular biologist at the University of Texas, Austin, and one of the state's expert witnesses in the case, maintains that the contamination of two controls does not invalidate the final findings.

Conque said in his January decision that those are issues that should be addressed at the trial. With proper cross-examination and expert testimony from the defense witnesses, the jury would not be unduly confused about the significance of the data. He did, however, forbid the prosecution from implying that the phylogenetic analysis can prove direct transmission. The prosecution agrees that the DNA analysis is only "a single piece of the puzzle."

Myers, who has assembled an HIV sequence database at Los Alamos and was one of the leading scientists in the Florida dentist case, says the defense experts have relevant and well-reasoned arguments, but he believes the judge made the correct decision. "I think the judge understood ... that there is sufficient evidence that the viruses are related. Why they are so related remains to be seen." He agrees with the defense experts, however, that there is some danger that the jury could be misled by the scientific luster of DNA analysis. "If additional evidence does not come forward," he says, "it would be unfortunate, because it would give undue emphasis to the technology."

Adds Myers: "The experts shouldn't carry the weight; the totality of the evidence should."

–Gretchen Vogel

ASTRONOMY

Spotting a Gamma Burst's Afterglow

Dutch and Italian astronomers are closing the net on the culprits in gamma-ray bursts, one of astronomy's greatest mysteries. In the early morning of Friday, 28 February, a burst of gamma rays erupted in the constellation Orion, triggering a dedicated detector on board the Italian-Dutch satellite Beppo-SAX. At the same time, one of the satellite's two Dutch wide-field x-ray cameras, which have a much sharper resolution than the gamma detector, caught the burst. That enabled scientists to pinpoint its position much more accurately, to an area much smaller than the full moon. A mere 8 hours later, controllers pointed the sensitive narrow-field x-ray cameras on the satellite at the suspect position, revealing a rapidly dimming x-ray source that had not been there before.

BEPPO-SAX/SDC/ASI

Burst sentinel. The Beppo-SAX satellite.

SAX had apparently caught the first glimpse ever of the object responsible for the original blast as it cooled off, detecting it just before it vanished. "Had the burst occurred over the weekend, we wouldn't have been able to respond so quickly," says John Heise of the Utrecht laboratory of the Space Research Organization Netherlands. Astronomers around the world are now aiming their instruments at the site of the x-ray object, hoping to pick up more clues to the nature of the event that generated the burst.

Since their discovery almost 30 years ago, over a thousand gamma-ray bursts have been observed at random positions in the sky, but astronomers do not have the faintest idea whether they originate near our Milky Way galaxy or in the far reaches of the universe. Because most gamma detectors have a very low positional accuracy, it has never been possible to link a burst to a known astronomical object such as a galaxy or star.

Beppo-SAX, named after Italian x-ray astronomer Giuseppe "Beppo" Occhialini together with the acronym for Satellite per Astronomia in Raggi-X, could change that, because it carries both a gamma-ray detector and wide-field x-ray cameras, says Heise, the x-ray camera project scientist. The x-ray cameras can quickly narrow down the position of any gamma-ray source that happens to be in their field of view. Launched last April, the satellite made its first simultaneous detection last fall (*Science*, 4 October 1996, p. 38).

This time, the cooling x-ray source spotted by the narrow-field cameras has given searchers an even more precise fix on the position of the burst. As a result, the announcement of the detection by Enrico Costa of Italy's Space Astrophysics Institute and his colleagues in a 1 March circular of the International Astronomical Union has caused a flurry of activity at observatories all over the world. Dale Frail of the National Radio Astronomy Observatory, for example, observed the burst region with the Very Large Array radio telescope near Socorro, New Mexico. In a 6 March circular, Frail reports that measurements on 1 and 4 March reveal a suspect radio source. But according to Heise, it is too early to say for sure whether this source is related to the gamma-ray burst.

To solve the gamma-ray burst mystery, astronomers realize they will probably have to bring down their response time to less than 2 hours after the gamma-ray detection, to catch the burster while it is still glowing brightly. "The last time, our response time was 16 hours," says Heise. "Now it's reduced to eight. We're making progress."

–Govert Schilling

Govert Schilling is an astronomy writer in Utrecht, the Netherlands.

NATIONAL ACADEMY

Court Invalidates Expert Panel Report

Three U.S. activist groups last week won a preliminary injunction in the first case testing a recent court ruling that advisory committees of the National Academy of Sciences (NAS) must conduct their business in public. A lower court judge in Washington, D.C., agreed with a claim by the New York–based Natural Resources Defense Council (NRDC) and two other organizations that because a panel of scientists formed to study the "scientific and technological readiness" of a planned $1.1 billion laser-fusion project had operated behind closed doors, the Department of Energy (DOE), which commissioned the report, could not use its findings.

The ruling has put DOE in the awkward position of saying it doesn't really need the report, which cost taxpayers $335,700. Ground breaking for the facility—the National Ignition Facility, or NIF—at Lawrence Livermore National Laboratory in Livermore, California, will proceed next month with or without the report, according to DOE. Coming on top of the earlier ruling, the decision also suggests that the much-cherished confidentiality of academy panels may be a thing of the past. The NAS argues that opening panel meetings would compromise its ability to give objective, scientific advice. "We're scratching our heads trying to figure out how in the world we could be an independent advisory body under those constraints," says NAS Executive Director William Colglazier.

The stage was set for the NRDC challenge in January, when the D.C. Circuit Court of Appeals agreed with an animal-rights group that the NAS was required to adhere to the Federal Advisory Committee Act (FACA), which states that panels formed to advise the government must open their proceedings to public scrutiny (*Science*, 17 January, p. 297). The academy has requested a rehearing of that decision.

Meanwhile, NIF opponents decided to try to use the January ruling to block the NIF report, which was due out in early March.