Evolution of DNA as an Accepted Courtroom Science Has Contributed to a Backlog in Laboratory Testing

by the Hon. Joseph A. Migliozzi Jr. and Alexander R. McDaniel

Since first introduced in American crime laboratories in the late 1980s, deoxyribonucleic acid ("DNA") profiling has evolved into a reliable and, at least within the criminal justice system, an anticipated investigatory practice in many cases. The Timothy Spencer case (a.k.a. the Southside Strangler), which involved a series of murders in 1987 and 1988, resulted in a 1994 conviction based on DNA evidence, thereby starting a nationwide trend in genetic fingerprinting in serial murder cases.[1] With the rapid evolution of reliable DNA testing to this day, so too has the need and reliance on such evidence among lawyers increased exponentially.

Typically, lawyers for either side in a serious felony case in the mid-1990s would have been required to request the court to order that DNA testing be performed by the Virginia Department (then Division) of Forensic Science ("the Department").[2] If ordered to conduct DNA testing, the Department would then begin a lengthy testing procedure involving a relatively new, yet extremely precise science. At the time, DNA profiling used the Restriction Fragment Length Polymorphism ("RFLP") method, which essentially involved releasing the DNA from a sample and cutting it into fragments of various lengths using a restriction enzyme. These fragments were then separated by size using gel electrophoresis and adhered to a membrane. Radioactively labeled DNA probes targeting up to six specific genetic loci were then applied sequentially to the membrane which, when exposed to x-ray film, produced separate images. These images collectively comprised the DNA RFLP profile and allowed for the comparison of the fragment lengths between an evidence sample and a known individual's sample. Once the results of the DNA testing were reported and provided to the court, the lawyers would then at trial begin the long and tedious performance of arguing to the judge and jury what DNA evidence was, why it should be admitted, and why it should be relied upon as scientifically precise evidence.

Today, lawyers do not have to make such a performance because DNA has been accepted as a reliable and, often times, necessary

form of scientific evidence. Additionally, forensic laboratories across the country have incorporated a much more discriminating and less time-consuming method of DNA profiling. Polymerase Chain Reaction ("PCR") testing, incorporated within the Department's laboratories in the late 1990s, is a simpler and more cost-effective method for developing DNA profiles for laboratory comparisons. However, as the profiling becomes more efficient and less time-consuming, the work load has simultaneously increased beyond capacity. In May of 2018, the average turnaround time for forensic biology casework exceeded 180 days.[3]

This article will address why the Virginia Department of Forensic Science is currently overwhelmed by the orders and requests for DNA testing throughout the commonwealth and what is involved along the process. The article will also briefly discuss the Department, give a detailed overview of PCR testing, and discuss the reasons for the current turnaround times in DNA testing.

The Department

The Department was created, albeit as a bureau, by the General Assembly in 1972.[4] Over time, the Department has increased in size, was elevated to a department, and moved under the Secretary of Public Safety.[5] The Department provides forensic services for over 400 law enforcement agencies, but remains an independent agency.[6] The Department's primary duty is "to provide forensic laboratory services upon request" in criminal cases.[7] The Department is independent and available to not only law enforcement and prosecutors, but also to criminal defendants and their counsel.[8] The Department has testing capabilities in the following fields: breath alcohol, controlled substances, digital and multimedia evidence, firearms and toolmarks, forensic biology, latent prints and impressions, toxicology, and trace evidence.[9] The Department's main office is located in Richmond, and it has four laboratories in Virginia: Richmond, Manassas, Norfolk, and Roanoke.[10] DNA analysis falls under the purview of the forensic biology section. Each laboratory is capable of forensic biology testing.

How DNA is Tested[11]

The first step of a forensic biology examination is often its most time-consuming step. The examiner will visually inspect each piece of evidence, typically with the aid of microscopes and alternate wavelengths of light, for the existence of biological material to test. An examiner can encounter many different pieces of physical evidence including clothing, bedding, buccal swabs, firearms, vehicles, and anything else that could contain biological material or upon which biological material may have been deposited. This process can take days or weeks to complete in large or complex cases. Evidence can also be submitted to the Department in the form of a Physical Evidence Recovery Kit ("PERK") from sexual assault victims. When an examiner finds suspected biological material, the examiner will take a small cutting, swabbing, or scraping of the piece of evidence and place it in a tube.

For high quality samples, the amount of DNA in approximately 10 to 20 cells is sufficient to develop a DNA profile using PCR technology. Once a cutting, swabbing, or scraping of suspected biological material is placed into a tube, chemicals are added to break open the cells and release the DNA. The resultant liquid containing the cellular material and DNA is loaded for processing by a robotic liquid handler. The robotic system is capable of handling up to 96 samples simultaneously and automates the removal of the cellular material and purification of the DNA. The amount of total human (or upper primate) DNA as well as the amount of male DNA present in each sample is then determined. Finally, the robotic system, based upon the amount of DNA measured to be present in each sample, is used to optimize the amount of each sample to be placed into a new tube along with chemicals that allow the PCR reaction to occur.

The loci an examiner tests are non-trait predictive areas of the DNA strand. The Department is statutorily forbidden to test areas that indicate propensities of an individual for hereditary diseases or cancer.

Next, the samples are placed in a thermal cycler instrument that facilitates the PCR process resulting in millions of copies of the specific portions of the DNA of interest.

Once the copies are made, the samples are run through an instrument that separates

them by size and allows for visualization using computer software. The resultant data is an electropherogram, which is a graph that looks like a series of peaks. This is a graphical representation of the DNA profile. The peaks represent the presence of particular DNA types at each area ("locus") tested. The height of a peak correlates to how much of that particular DNA type is present in the sample. The examiners test 24 areas ("loci") along the DNA strand simultaneously, which is a recent increase from the previous testing of 16 loci. Humans share over 99 percent of DNA with each other, so the examiner tests loci that are known to show variation between individuals. The more loci an examiner analyzes, the more discriminating the profile becomes, meaning the less likely it is that another person's DNA profile will match. The loci an examiner tests are non-trait predictive areas of the DNA strand. The Department is statutorily forbidden to test areas that indicate propensities of an individual for hereditary diseases or cancer. Once the examiner has developed a DNA profile from an evidence sample, the examiner can compare it to a DNA profile developed from a known individual's sample to determine if the known individual could or could not have contributed the DNA in the evidence sample.

The largest contributing factor to the Department's DNA backlog is a recent change in Virginia law. In 2016, the General Assembly required that all PERKs received by law enforcement must be submitted to the Department for analysis within 60 days with few exceptions.

The results of the testing are reported using specific terminology. If the evidence DNA profile is different from the DNA profile developed from the known individual's sample, and the known individual could not, therefore, have contributed the DNA in the evidence, the examiner will report that the known individual is eliminated as a contributor. If the evidence DNA profile and the DNA profile developed from the known individual's sample match, or are the same, the examiner will report that the known individual cannot be eliminated as a contributor. For cases in which the reported conclusion is non-elimination, the examiner will then calculate the probability of randomly selecting an unrelated individual whose DNA profile would match the evidence profile, which is a statistic that provides information as to how rare or common the evidence profile is. Because the examiner tests 24 loci, this probability can be as rare as one in greater than the global population. Finally, an examiner may report that the DNA profile developed from the evidence is of no value or that insufficient information exists to draw a conclusion regarding the known individual as a contributor. This can occur when there is not enough DNA present to develop a useful profile, there is DNA from too many sources mixed together, or what information is developed is too limited to determine if the known individual could or could not have contributed.

The final step an examiner takes is to upload the DNA profile into the Combined DNA Index System ("CODIS"). The profile is searched through the database to see whether the same profile is associated with another sample taken and entered by Virginia or other jurisdictions. If there is a match between the sample and an existing entry in CODIS, that is called a hit. The examiners will continually check their samples in CODIS for a hit and will report the hit to the submitting agency.

In addition to the typical PCR testing described above, examiners can use two other types of PCR tests: mitochondrial DNA testing or Y-STR testing. Examiners can test the mitochondria of the cell. The mitochondria are the part of the cell responsible for providing energy to the cell. Because mitochondria are inherited only from the mother, the mitochondrial DNA profiles of all individuals in the same maternal line will be the same. This testing method is common for testing the DNA of unidentified remains.

Examiners test the male Y-chromosome with Y-STR testing. This type of testing is common in rape and assault cases. This testing is also conducted using PCR technology, but all loci tested are on the Y-chromosome. Therefore, any female DNA in the sample is not targeted and the profile developed is only that of any male(s) present. The Y-chromosome testing is not as discriminating as the typical PCR testing used by the Department because all males in the same paternal line will inherit the Y-chromosome in its entirety and therefore share the same Y-chromosome DNA profile. The rarity of a Y-chromosome DNA profile is typically

around one in one thousand, rather than one in greater than the global population.

Sometimes a piece of evidence submitted to the Department must be tested through multiple disciplines. When that is the case, the forensic biologist will test for DNA first and the latent prints examiner will test for fingerprints on a different area of the piece of evidence.

Reasons for the Delay

The largest contributing factor to the Department's DNA backlog is a recent change in Virginia law. In 2016, the General Assembly required that all PERKs received by law enforcement must be submitted to the Department for analysis within 60 days with few exceptions.[12] The law increased the number of PERKs submitted to the Department, such that as of January 2018, the increase in submissions accounted for a 25 percent increase over three years.[13]

In addition, the Department was provided six additional DNA examiners by the new legislation.[14] It takes one year to train a new examiner fresh from college and about six months to train an examiner previously qualified by another laboratory system. The new examiners are trained by the current examiners, taking them away from their own testing responsibilities.[15] Using grant funds obtained in collaboration with the Office of the Attorney General, DFS has outsourced the testing of PERKs collected prior to the comprehensive PERK legislation being effective. As part of the grant, DFS examiners review the data from the private laboratory, upload eligible profiles into the Data Bank for searching, and report any subsequent hits. DFS examiners will also conduct any subsequent analyses in these cases when direct comparisons are required. All examiners also undergo training to examine the increased analysis of the twenty-four loci on the DNA strand. Because the examiners are analyzing more loci, the analysis and statistical calculations take longer.[16]

Another factor that impacts an examiner's turnaround time is a defendant's Confrontation Clause rights. The United States Supreme Court in *Melendez-Diaz* held that the testing by a forensic examiner is testimonial under the Confrontation Clause and that a criminal defendant has a right to cross examine the forensic examiner.[17] The Court in *Bullcoming* held that a criminal defendant's Confrontation Clause rights required the actual examiner to testify rather than a surrogate examiner.[18] What this means for the Department is that examiners are often interrupted from their forensic examinations to travel to court to testify or to meet with attorneys to discuss their testimony. Particularly in the western part of the commonwealth, an examiner may take an entire day to travel to court, testify, and return.

Although the backlog is significant, the Department anticipates that the increased turnaround time will decrease in the coming months as new examiners are trained and begin performing case work.

Conclusion

Judges and practicing attorneys must be aware of the backlog for DNA analysis so they can schedule future court appearances accordingly. Although the Department is taking steps to reduce the backlog, it will take some time for those efforts to come to fruition. One practice that would aid the Department is to send requests for DNA testing as early as possible. If an item has been tested by one forensic section (latent prints or firearms, for example), it is unlikely that piece of evidence will give reliable DNA evidence as some testing methods do not require the sterile environment that DNA testing requires. In addition, the Department is offering a class for attorneys at each of their laboratories in the fall of 2018. This class is geared to help attorneys and judges learn more about the procedures and methods behind DNA testing.[19] The judicial system will operate much more effectively in the administration of justice when attorneys and judges understand both DNA testing methods and procedures and what is contributing to the current backlog of casework.

Endnotes:

1 *See generally Spencer v. Commonwealth*, 238 Va. 563, 385 S.E.2d 850 (1989) (affirming the trial court's rulings regarding the admissibility of DNA evidence).

2 The Authors would like to thank the Department for giving the Authors a tour of the Richmond laboratory and their competent answers to many questions.

3 *Average Case Turnaround Times*, Va. Dep't Forensic Sci., http://www.dfs.virginia.gov/about-dfs/current-turnaround-times/, (last visited June __, 2018).

4 *About DFS*, Va. Dep't Forensic Sci., http://www.dfs.virginia.gov/about-dfs/, (last visited June __, 2018).

5 *Id.*

6 *Id.*

7 Va. Code Ann. § 9.1-1101(A) (Repl. Vol. 2012).

8 *Id.* §§ 9.1-1101, -1104.

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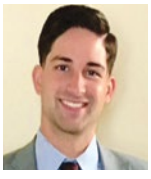

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9 *Forensic Services*, Va. Dep't Forensic Sci., http://www.dfs.virginia.gov/laboratory-forensic-services/, (last visited June __, 2018).
10 *Regional Labs*, Va. Dep't Forensic Sci., http://www.dfs.virginia.gov/regional-labs/, (last visited June __, 2018).
11 This section was written by the Authors, but members of the Department have assisted in the editing of this portion to ensure accuracy. For further research into the methods and procedures of the Department, see *Manuals and Procedures*, Va. Dep't Forensic Sci., http://www.dfs.virginia.gov/documentation-publications/manuals/, (last visited June __, 2018).
12 Va. Code Ann. § 19.2-11.8 (Cum. Supp. 2017).
13 Notice, Department of Forensic Science, Notice Regarding Forensic Biology (DNA) Workload (Jan. 24, 2018) (on file with author).
14 *Id.*
15 *Id.*
16 *Id.*
17 *Melendez-Diaz v. Mass.*, 557 U.S. 305, 310–11 (2009).
18 *Bullcoming v. N.M.*, 564 U.S. 647, 661 (2011).
19 *Training for Attorneys*, Va. Dep't Forensic Sci., http://www.dfs.virginia.gov/training/dnatraining/, (last visited June __, 2018).