

NOT FOR PUBLICATION WITHOUT THE
APPROVAL OF THE APPELLATE DIVISION

SUPERIOR COURT OF NEW JERSEY
APPELLATE DIVISION
DOCKET NO. A-6218-07T4

STATE OF NEW JERSEY,

Plaintiff-Respondent,

v.

GEORGE CALLEIA,

Defendant-Appellant.

APPROVED FOR PUBLICATION

June 22, 2010

APPELLATE DIVISION

Argued March 2, 2010 - Decided June 22, 2010

Before Judges Fuentes, Gilroy and Simonelli.

On appeal from Superior Court of New Jersey,
Law Division, Monmouth County, Indictment No.
06-02-0235.

Edward C. Bertucio, Jr., argued the cause for
appellant (Hobbie, Corrigan, Bertucio & Tashjy,
attorneys; Mr. Bertucio, of counsel and on the
briefs).

Frank J. Ducoat, Deputy Attorney General, argued the
cause for respondent (Paula T. Dow, Attorney General,
attorney; Mr. Ducoat, of counsel and on the brief).

The opinion of the court was delivered by

FUENTES, J.A.D.

A Monmouth County jury found defendant George Calleia
guilty of murdering his wife, Susan Calleia, N.J.S.A. 2C:11-
3(a)(1) and/or (2), tampering with physical evidence, a fourth

degree offense under N.J.S.A. 2C:28-6, and hindering apprehension, a third degree offense under N.J.S.A. 2C:29-3(b)(1) and/or (4). The court sentenced defendant to an aggregate term of fifty years, with an eighty-five percent period of parole ineligibility and a five-year period of parole supervision, both pursuant to the No Early Release Act (NERA), N.J.S.A. 2C:43-7.2. The court also imposed the relevant mandatory fines and penalties.

Defendant now challenges his conviction and sentence on appeal. Although we reverse defendant's conviction on other grounds, because defendant presumably will be tried anew on these charges, we also address defendant's attack on the trial court's admission of DNA evidence presented by the State as part of its case against him. Specifically, we hold that the trial court correctly admitted Y-STR DNA evidence, in the form of biological material found under the victim's fingernails, under N.J.R.E. 702 and the standards established by our Supreme Court in State v. Harvey, 151 N.J. 117, 167 (1997), cert. denied, 528 U.S. 1085, 120 S. Ct. 811, 145 L. Ed. 2d 683 (2000). The trial court thus correctly admitted the testimony of the State's expert witness, who opined that this DNA evidence showed that defendant could not be excluded as a "donor" of the biological material.

I

We derive the following facts from the evidence presented at trial.

A

In October 2005, defendant shared his marital residence in the Township of Holmdel with his wife Susan and their eight-year-old daughter "Ana" (a fictitious appellation to protect the child's privacy). At that time, defendant was employed as the director of sales and marketing for a computer software company. Susan was described by those who knew her as a "stay-at-home mom" who took an active part in her daughter's social and academic life.

At approximately 6:15 a.m. on October 21, 2005, defendant telephoned the 911 Center at the Monmouth County Sheriff's Department to report that his wife was missing. The call was referred to the Holmdel Police Department which in turn dispatched Patrolman David D'Arcy to the Calleia residence. As D'Arcy approached the house, defendant opened the door and motioned for him to come inside. Once inside the house, defendant told D'Arcy that his wife Susan was missing. Defendant stated that he first became aware of her absence when he entered the garage at 5:30 a.m. to leave for work and

discovered that Susan's car was gone. He then searched the house to confirm that she was not there.

In response to D'Arcy's questions, defendant indicated that the last time he had seen his wife was the previous evening. He had been watching television while waiting for her to return home; defendant was upset because she had left without telling him where she was going. When Susan returned home at around 8:00 p.m., they had a "verbal dispute" which they "resolved," and then defendant went upstairs to bed. During further questioning by D'Arcy, defendant indicated that his wife had no history of mental illness, was in good physical health, and was not taking any medication. D'Arcy described defendant's demeanor during this encounter as "very nervous"; he was trembling, spoke in a subdued tone, and persistently looked at the ground.

D'Arcy returned to the police station and shared the information he had obtained with the detective bureau. As a result, the Holmdel Police Department issued an alert or "TRAK message," indicating that defendant had reported his wife, Susan Calleia, missing; her name was also entered into the National Crime Information Center (NCIC)¹ database. Later on the morning

¹ The National Crime Information Center is a computerized index of criminal justice information maintained by the FBI. National
(continued)

of October 21, 2005, Holmdel detectives contacted the Monmouth County Prosecutor's Office to request assistance with their investigation.

At approximately 4:00 p.m., Detective Sergeant Brian Veprek, who was assigned to the major crimes unit in the prosecutor's office, reported to the Calleia residence, where Holmdel Detective Sergeant James Smythe briefed him on the case. Veprek testified that when he extended his right hand to shake defendant's hand, defendant did not extend his hand in return and did not shake Veprek's hand. Veprek recalled that defendant was wearing a long-sleeved white shirt that hung below the tips of his fingers on both hands. He also noted that defendant continually looked down without making eye contact with him.

Veprek and Smythe told defendant that they would like to obtain a formal statement from him concerning his wife's disappearance and asked him to accompany them to the police station. According to Veprek, defendant asked if it was really necessary since this was "just a missing persons investigation." Defendant then stated: "I'm not going to your house, I've seen Law and Order and NYPD Blue, and I know what happens when I'm in your house." Veprek asked defendant if a secretary from his

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Crime Information Center (NCIC) - FBI Information Systems,
<http://www.fas.org/irp/agency/doj/fbi/is/ncic.htm>.

office could come to his home with a computer to take his statement; defendant agreed, stating: "if it's necessary."

B

The secretary arrived at the Calleia house at approximately 4:53 p.m. Defendant's statement consisted of his answers to questions posed to him by the interrogating officers; it covered seventeen pages and was taken down verbatim by the secretary using a laptop computer. The interview lasted one hour and thirty-four minutes, with a one-minute break to permit defendant to walk the family dog. The statement concluded at 6:27 p.m. It is important to note that at the time he gave this statement, the police had no reason to believe that defendant was in any way responsible for his wife's disappearance.

Responding to Veprek's direct questions, defendant indicated that he arrived at his house the night before his wife's disappearance at approximately 6:20 p.m. When he entered the residence through the garage, he noticed that his wife was home. He encountered Susan in the "laundry room/kitchen area," where she told him that she was going out for "three maybe four hours and [he] asked her where she was going and she said she was late and she had to go." She did not tell him where she was going and left without further incident.

When asked to describe "the tone of the conversation," defendant rejected the interrogating officer's characterization of the exchange as a "conversation," describing the interaction instead as something his wife said to him as she was walking out of the house. He described her demeanor as "[c]asual cordial" and denied that either one of them "screamed" or "hollered" at the other. He admitted, however, that it was unusual for his wife to leave the house without telling him where she was going. When asked: "How did it make you feel when your wife told you that she was leaving for three or four hours and did not tell you where she was going," defendant responded: "Concerned . . . I don't know if she didn't want to tell me or if she was in too much of a rush to tell me. But I was concerned." (Emphasis added).

The next and last time defendant saw his wife alive was at approximately eight o'clock that same night. He gave the following description of the encounter:

About 8:10 [p.m.] is when my wife came home and that is when I asked her where she was and [told her] that I was concerned and that the car got stuck the other day, and you should have told me where you were [']cause I was concerned. She said I don't have to tell you where I was, I don't ask you where you go. I said yes you do and I always tell you. What I didn't tell you [before] was when she came in she was agitated so I don't know where she was or what transpired but she was very agitated when she came back.

She said she wasn't in a good mood and I said could you tell me why, what happened, where did you go. And then what I said before, I went backwards I put one thing in front of the other.

[(Emphasis added).]

When asked to explain how his wife was agitated, defendant simply responded: "By the way she was putting her stuff [jacket and notepad] down."

Defendant described his relationship with his wife as "cordial" and "friendly." By contrast, he described his marriage as "strained" and not "as close as we used to be." The following exchange illuminates this point:

What has separated you and your wife that you are not as close as you used to be?

Good question. I think it was on her part, it was an accumulation[.] She said in the past (sic). I spent twenty[-]five years in one firm, and it was a merger and the other firm took control and for the past year and a half[,] two years I have been very depressed over the fact that people that I have worked with for twenty years have been let go, the management, the people don't know the business. They are trying to run it, they don't understand it. It wasn't a happy time. So what I mean is by it was not a happy time for me is that I might have neglected my wife [']cause I was focused on that.

What are the sleeping arrangements between you and your wife?

For about a month we have been in separate beds in separate parts of the house.

When asked what led him to think that his wife was "missing," defendant indicated that he noticed that her car was not parked in the garage and that she was not otherwise in the house. Thereafter, following the advice of the officer who responded to his 911 call, he followed his morning routine. Defendant took his daughter to school at approximately 7:30 a.m., returned home therefrom at about 8:20 a.m., and "drove around [for about 45 minutes] but stayed home most of the day."

He called his wife's cell phone two or three times in the early afternoon hours. When asked why he did not call his wife on her cell phone before calling the police, defendant responded that he was "in shock that she wasn't there and I just thought that if she wasn't there it can't be good." (Emphasis added).

When asked to clarify what he meant by this, defendant stated:

She has never been out of the house, never, in the morning, never not seen her or her car whatever. I don't know, I wasn't thinking straight. I thought, I don't know what I thought. I was in shock.

In response to questions regarding the argument he and his wife had the night before her disappearance, defendant indicated that his daughter was awakened because "[w]e were getting so loud." He told her to go back to sleep and he and his wife returned to the "laundry room/garage." Although he did not

remember whether the garage overhead doors were open, he recalled that he could see "the light from the street."

There was a one minute break at this point in the interrogation, from 5:43 p.m. to 5:44 p.m. When the interrogation resumed, the police refocused the conversation on evidence concerning Susan's activities. According to defendant, the spare bedroom appeared unused, thus leading him to think that his wife had not slept there during the night. As to her personal items, although defendant did not know whether any of her toiletries had been taken, her pocketbook, which held her credit cards, was missing.

The interrogation next focused on the stability of the marriage. According to defendant, his wife voluntarily told him that she was not seeing anyone else. When asked whether his wife had ever asked him for a separation or divorce, defendant responded: "She says she needs her space. Those are her words, never said separated or divorce." When asked whether he or his wife had seen or consulted with an attorney, he said: "I haven't, my wife said she wanted to speak to somebody just to find out any implications about buying another house." He assumed that the reference to "seeing somebody" meant consulting with an attorney. With respect to their daughter, defendant indicated that they had discussed a joint custody arrangement.

Despite the fact that he and his wife had been sleeping in separate bedrooms and were discussing issues such as child custody and maintaining separate residences, defendant claimed that "[f]or the past couple of weeks things have been getting nice again." He further stated that "[u]p until a month ago I thought everything was good." Overall, defendant denied ever physically assaulting his wife and denied having any knowledge of what could have caused her disappearance.

At the end of the interrogation, the police gave defendant a printed copy of the statement, asked him to review it and initial each page, and requested that he sign the affirmation indicating that "the facts contained herein are true." Defendant read the statement as requested, but he initialed only pages 1-7 of this seventeen page document; he also refused to sign the affirmation, writing instead: "I'm not comfortable signing all of the pages or the end without an attorney present."

As the detectives were leaving his home, defendant suddenly said: "I think my wife was abducted at 5:30 this morning while going to Welsh Farms to get milk." According to Veprek, defendant also asked how they "were making out" on the burglaries that had occurred on Goldsmith Drive. Smythe replied that an investigation was underway and that an arrest was

expected soon. Defendant then stated that during the summer, someone had tried to break into his house and perhaps Susan's disappearance was tied to that alleged incident. When Smythe asked him why he had not mentioned these things before, defendant replied that he did not think that they were important.

C

Veprek and Smythe returned to the Calleia residence at 3:20 a.m. on October 22, 2005, with a warrant to search the premises. They were accompanied by other detectives from the prosecutor's office, patrol officers and detectives from Holmdel, and personnel from the New Jersey State Police Laboratory. When defendant opened the door, he was wearing the same long-sleeved white shirt he had worn the previous day. He kept both of his hands inside the sleeves of the shirt or in the pockets of his sweatshirt. Veprek and Smythe accompanied defendant to wake his daughter and take her to a neighbor's house. Defendant returned home and stayed there throughout the search; he was accompanied at all times by Veprek and Smythe.

At one point, defendant asked Veprek if he could change his clothes. Veprek advised him that he had to escort him to observe that nothing was tampered with or removed. Veprek and defendant went into defendant's bedroom closet while Smythe

stood in the doorway. Veprek took out the clothes that defendant requested and handed them to him. When defendant reached out to take the clothes with his right hand, Veprek and Smythe observed that his right hand was badly swollen and had a large cut just below the middle knuckle of his middle finger. In response to Veprek's question about the injury, defendant indicated that he received it when he had punched a wall in his house during the argument with his wife the night before her disappearance. According to Smythe, when he asked defendant to show him the wall so that the police could "properly document that and have it photographed and videotaped," defendant "[f]or the first time with (sic) our interaction he looked up and stared at [the detectives] for a good five seconds . . . [t]hen he looked back down at the ground." At this point, Smythe commented to defendant that the injury "looked like it was from someone's teeth." Both Smythe and Veprek testified that defendant then said the following:

I want to recant what I just told you . . .
I backhanded Susan in the face on Thursday
night in the garage. That is why she left
the residence and did not return . . . I
want to recant that . . . I went to hug
Susan and she bit me on the hand.

When Veprek asked defendant why, if in fact Susan had bitten him, there was only one set of teeth marks on his hand and not

two, defendant put his head down and did not say anything further.

Defendant signed a consent form allowing the police to photograph his right hand, and although he refused to do so in writing, he verbally consented to the taking of a buccal swab of the injury. Thereafter, at defendant's request, Veprek and Smythe drove him to a hospital to be treated for the injury to his hand.

D

At 11:53 a.m. on October 22, 2005, police located a vehicle matching the description of Susan's Lexus SUV in a remote area behind the PNC Arts Center. The patrol officer who found the vehicle looked inside and saw what appeared to be a discolored female hand sticking out from under a mat in the back cargo compartment. Veprek, Smythe, and a team of forensic investigators and other law enforcement personnel responded to the scene.

The vehicle was locked and the keys were inside on the front seat. When the police broke into the back hatch of the car, they discovered Susan's body in the cargo area covered by a pink yoga mat. According to Veprek, there was extensive bruising and trauma to her face and a pool of blood under her head. She was wearing socks, a red sweater, and an unfastened

bra. Her boots, black pants, and underpants were found inside the cargo area next to her body.

Later that afternoon, Veprek and Smythe took a statement from the Calleias' next-door neighbors, Frederick and Marilyn Baxter. According to Mrs. Baxter, at about 8:15 on the evening before Susan was reported missing, she was in her driveway when she heard screams coming from the Calleias' garage. Although she recognized Susan's voice as the person screaming, she could not discern whether any words were said. Mrs. Baxter characterized the screams as "blood-curdling." At her request, her husband telephoned the Calleias and left a message on their answering machine. He never received a call back.

Dr. Frederick DiCarlo, an assistant medical examiner with the Monmouth County Medical Examiner's Office, performed the autopsy on the morning of October 23, 2005. According to Dr. DiCarlo, Susan was not suffering from any natural disease or physical abnormality at the time of her death. An examination of her body revealed that she received traumatic injuries to her head, neck, chest, arms, and legs. There was no evidence, however, that she had been sexually assaulted or of sexual activity prior to her death. Dr. DiCarlo opined that the

immediate cause of Susan's death was manual strangulation;² if she had not been strangled, Dr. DiCarlo believed that the blunt force trauma to her head would have resulted in death within a short time. In Dr. DiCarlo's opinion, the hemorrhaging that occurred around Susan's head injuries indicated that she was beaten for about fifteen or twenty minutes before she was strangled. He estimated the time of death as 9:00 p.m. on October 21; he admitted, however, that her death could have occurred at any time between 4:00 p.m. and midnight.

[AT THE COURT'S DIRECTION, THE ONLY PUBLISHED PART OF THIS OPINION IS THE COURT'S DISCUSSION OF DEFENDANT'S ARGUMENT THAT THE TRIAL COURT ERRED IN DENYING HIS MOTION TO BAR THE STATE'S EXPERT WITNESS FROM TESTIFYING ABOUT Y-STR DNA EVIDENCE. DEFENDANT ARGUES THAT SUCH EVIDENCE DID NOT SATISFY THE STANDARD FOR ADMISSIBILITY UNDER FRYE V. UNITED STATES, 293 F. 1013 (D.C. CIR. 1923).]

IV

At trial, defendant challenged the admission of Y-STR DNA evidence, which demonstrated that he could not be excluded as a donor of biological material recovered from under the victim's fingernails. At oral argument before us, the State urged us to consider and affirm the trial court's decision to admit the Y-

² Dr. DiCarlo defined manual strangulation as "force by [one's] limb that causes compression of the neck resulting in strangulation." He explained that this can be performed by using fingers, the ball of the hand, the wrist, or even the forearm. By contrast, ligature strangulation is performed by wrapping a rope, a belt, a cable cord, or some other type of ligature around the victim's neck.

STR DNA evidence, even if we were to reverse defendant's conviction on other grounds. The State argued that appellate approval of this scientific evidence will settle the question among the trial courts, at least until the Supreme Court decides otherwise.

Given the strong likelihood that this evidence will again emerge as a key part of the State's case against defendant, we will address the propriety of its admission by the trial court.

A

In a criminal case, we review a trial court's decision to admit novel scientific evidence by applying an expansive de novo standard of review that goes beyond the record developed before the trial court to account for and consider the latest and most reliable scientific developments in the field under review. Harvey, supra, 151 N.J. at 167-68. We are thus obligated to

scrutinize the record and independently review the relevant authorities, including judicial opinions and scientific literature . . . By reviewing post-trial publications, an appellate court can account for the rapid pace of new technology. The continuing review also recognizes that general acceptance may change between the time of trial and the time of appellate review. Moreover, by examining such additional information, an appellate court can prevent any injustice rendered by admission or exclusion of the evidence at the trial level.

[Harvey, supra, 151 N.J. at 167-68 (internal citations omitted).]

Generally, the admission of expert testimony is governed by N.J.R.E. 702, which provides:

If scientific, technical, or other specialized knowledge will assist the trier of fact to understand the evidence or to determine a fact in issue, a witness qualified as an expert by knowledge, skill, experience, training, or education may testify thereto in the form of an opinion or otherwise.

In order to be admissible under this Rule:

(1) the intended testimony must concern a subject matter that is beyond the ken of the average juror; (2) the field testified to must be at a state of the art such that an expert's testimony could be sufficiently reliable; and (3) the witness must have sufficient expertise to offer the intended testimony.

[State v. Kelly, 97 N.J. 178, 208 (1984) (addressing Evid. R. 56(2) now codified as N.J.R.E. 702).]

Here, defendant does not challenge the State's expert's qualifications to offer testimony regarding forensic DNA testing, nor does he contend that the science of Y-STR DNA analysis is within the ken of the average juror. The sole question before us is whether Y-STR DNA analysis has reached a level of development and acceptability within the relevant scientific community that an expert's testimony concerning it

can be deemed sufficiently reliable. Harvey, supra, 152 N.J. at 168.

Although in 1993 the United States Supreme Court abandoned the general acceptability standard in Frye v. United States, 293 F. 1013 (D.C. Cir. 1923) in favor of a more relaxed scientific reliability standard, Daubert v. Merrell Dow Pharmaceuticals, Inc., 509 U.S. 579, 113 S. Ct. 2786, 125 L. Ed. 2d 469 (1993), codified in Fed. R. Evid. 702, the test in New Jersey continues to be whether the scientific community generally accepts the reliability of the proffered evidence. State v. Chun, 194 N.J. 54, 91, cert. denied, __ U.S. __, 129 S. Ct. 158, 172 L. Ed. 2d 41 (2008); Harvey, supra, 151 N.J. at 170.

General acceptability of a particular scientific methodology can be established in three ways:

(1) by expert testimony as to the general acceptance, among those in the profession, of the premises on which the proffered expert witness based his or her analysis;

(2) by authoritative scientific and legal writings indicating that the scientific community accepts the premises underlying the proffered testimony; and

(3) by judicial opinions that indicate the expert's premises have gained general acceptance.

[Harvey, supra, 151 N.J. at 170 (quoting Kelly, supra, 97 N.J. at 210).]

The proponent of the evidence bears the burden to "clearly establish" each of these methods. Harvey, supra, 151 N.J. at 170.

General acceptance does not require a unanimous belief in the absolute infallibility of the technology or methodology at issue. Chun, supra, 194 N.J. at 91-92; In Re Commitment of R.S., 173 N.J. 134, 136 (2002). To meet this burden of general acceptability, the proponent of the evidence must prove that the technology is a "non-experimental, demonstrable technique[] that the relevant scientific community widely, but perhaps not unanimously, accepts as reliable." Harvey, supra, 151 N.J. at 171. "It is reliability that must be assured." R.S., supra, 173 N.J. at 136; see Kelly, supra, 97 N.J. at 210 (holding that "[t]he technique or mode of analysis used by the expert must have a sufficient scientific basis to produce uniform and reasonably reliable results").

B

Defendant argues that the trial court erred in admitting the Y-STR DNA evidence because that evidence lacked probative value and did not satisfy the standard for admissibility established by Frye. According to defendant, the error was

compounded by the State's expert, who opined that the Y-STR DNA profile obtained from biological material found under the victim's fingernails "matched" the profile obtained from defendant's reference sample.

In rebuttal, the State argues that the reliability of Y-STR DNA evidence has been established by its general acceptance in the forensic science community, in scientific and scholarly literature, and in other court proceedings. Although prior to this case no court in this state has addressed the admissibility of Y-STR DNA evidence, the State maintains that Y-STR analysis has been used in criminal trials in other states and in Canada.

The trial court first considered the admissibility of the State's scientific evidence in a N.J.R.E. 104 hearing outside the presence of the jury. The only witness who testified at this hearing was called by the State. The trial court admitted Edward J. LaRue, the Assistant Director of the New Jersey State Police DNA Laboratory, as an expert in the field of DNA analysis. LaRue testified that Y-STR DNA testing uses exactly the same methodology as STR DNA testing and is closely related to a number of DNA testing methods that have been accepted in judicial proceedings. The following scientific discussion is derived entirely from LaRue's testimony. We refer to that testimony at length here as a basis from which to assess whether

the State satisfied the first prong under the Harvey test: whether expert testimony can establish the general acceptance of Y-STR DNA testing. Harvey supra, 151 N.J. at 170.

General DNA Testing

The nucleus of a human cell contains twenty-three pairs of chromosomes. Chromosomes are tightly wound structures of deoxyribonucleic acid (DNA), a double-stranded molecule that is configured like a twisted ladder. The "rungs" of the DNA ladder form when a nucleotide or "base" on one strand binds to a base on the opposite strand.³ It is the combination of these bases that creates the entire inherited genetic code.

More than ninety-nine percent of human DNA is the same from person to person. Because the human genome consists of approximately 3.2 billion base pairs, however, even the small percentage of variation results in a large number of base pairs that differ between individuals. Due to the large number of possible base-pair combinations, each individual, with the exception of identical twins, has a unique genetic code. A locus is a specific spot or position on the chromosome. If the locus is responsible for producing a particular protein, it is referred to as a gene. If the locus does not produce a protein,

³ The four bases are guanine (G), cytosine (C), adenine (A), and thymine (T). An A always binds to a T; a C always binds to a G.

it is referred to as "non-coding DNA." Forensic science focuses primarily on the non-coding areas of DNA because that is where the most variation is found.

Since the early 1990s, scientists have used a technique known as polymerase chain reaction (PCR) to prepare a DNA sample for study. PCR is a method of multiplying a small amount of DNA in order to make a sufficient quantity to be detected by instrumentation. PCR amplification involves: heating the DNA solution to denature the double helix and create a solution of single-stranded molecules; adding a "primer," which is a short sequence of DNA base pairs intended to adhere to specific loci on the strands; and adding an enzyme that "reads" each strand and uses it as a template to build a new strand that is an exact copy of the original. The cycle is then repeated in a chain reaction that can make billions of copies of the original DNA sample. PCR was found to be scientifically reliable and hence admissible in a criminal proceeding in Harvey, supra, 151 N.J. at 160-61, 183.

One type of DNA testing that uses the PCR method is short tandem repeats (STR) analysis. A short tandem repeat is a non-coding area of DNA that has repeating sequences of nucleotides. Differences can be seen between individuals depending on the number of times a nucleotide sequence is repeated at a given

locus. Thirteen core loci have been identified by CODIS⁴ for use in STR analysis. These loci are differentiated from one another through the use of differently colored fluorescent tags that are attached to the primer during PCR amplification. The tagged specimen is placed in a capillary filled with a polymer gel and inserted into an instrument known as a "genetic analyzer." When an electric current is placed across the capillary, the DNA migrates through the gel column. Because short fragments climb faster than long fragments, a physical separation occurs. When a fragment reaches the end of the capillary, a laser excites its fluorescent tag and creates a very specific signal that is detected by the instrument. The signals obtained are represented on an electropherogram, which can be used to generate a DNA profile.

When loci on all twenty-three pairs of chromosomes are tested, the process is called autosomal STR DNA analysis. Y-STR analysis, on the other hand, involves the testing of loci on only one specific chromosome: the male "Y chromosome." Of the twenty-three pairs of chromosomes in a human cell, one pair is comprised of two "sex chromosomes" that determine whether a

⁴ The Combined DNA Index System (CODIS) is a searchable DNA database maintained by the FBI. It stores DNA profiles created by federal, state, and local crime laboratories. CODIS-National DNA Index System, <http://www.fbi.gov/hq/lab/codis/national.htm>.

person is male or female. In a female, both sex chromosomes are "X chromosomes." In a male, one sex chromosome is an "X chromosome" and one sex chromosome is a "Y chromosome." Thus, Y chromosomes can only be found in males.

Since the early 1990s, forensic scientists have been able to use specific short nucleotide sequences to differentiate the sex chromosomes from the other chromosomes and determine whether the DNA donor was male or female. In 2003, forensic technology was markedly advanced when the full Y chromosome nucleotide sequence was established. Since that time, over 200 different STR loci have been identified on the Y chromosome.

Y-STR DNA Testing

The Scientific Working Group for DNA Analysis Methods (SWGAM)⁵ has selected a core number of Y-STR loci for forensic examination. Commercial kits are available that provide primers that specifically target these loci. The State Police Laboratory uses the "Yfiler Kit" that is manufactured by Applied

⁵ According to LaRue, SWGDAM is a scientific board that advises the FBI and sets guidelines concerning how DNA analysis should be conducted. It is composed of both public and private sector scientists who set federal standards governing training and education of DNA analysts, protocols in DNA testing laboratories, and guidelines for technique validations. Before a laboratory may receive federal funding or upload results into the CODIS database, it must be audited and found to be in compliance with SWGDAM standards.

Biosystems, Inc.⁶ At all times, the Laboratory follows the SWGDAM guidelines for internal validations; a validation conducted for Y-STR testing showed that the Laboratory used here was in compliance with the federal guidelines.

The analytical procedure followed in Y-STR DNA testing is identical to that followed in autosomal STR DNA testing. The sample is extracted in the same manner, amplified by the PCR method, tagged with a primer, and detected in the genetic analyzer. The data is collected and represented in exactly the same way. The only procedural distinction is that the primer included in the test kit for Y-STR DNA analysis contains markers for the Y-STR loci specified by SWGDAM; the primer included in the test kit for autosomal STR DNA analysis contains markers for loci on all twenty-three chromosome pairs. The major difference between autosomal STR DNA analysis and Y-STR DNA analysis is in the interpretation and application of the test results.

An individual inherits his or her genetic code from his or her biological parents. Specifically with regard to autosomal STRs, the frequency of repeat sequences found in an individual's DNA is the result of random combinations of the repeat sequences found in the DNA of his mother and father. Because the mixing

⁶ See specifications for Yfiler®PCR Amplification Kit, <https://products.appliedbiosystems.com/ab/en/US/adirect/ab?cmd=c atNavigate2&catID=601709> (follow "specifications" tab).

of the parents' DNA information is random and each loci is independent of the others, it is possible to mathematically calculate the probability that any individual will possess a specific DNA profile through use of the "product rule." This means that the probability that an individual will inherit a particular repeat frequency at locus one is multiplied by the probability that he will inherit a particular repeat frequency at locus two, which is multiplied by the probability at locus three and so on.⁷

The probability is extremely low, one in one quadrillion, that the STRs on all thirteen loci of two different individuals will "match," i.e., that each corresponding locus will have the identical frequency of repeated nucleotide sequences. For this reason, if a thirteen-loci⁸ autosomal STR DNA profile from a forensic specimen matches a profile generated by a sample taken from a particular individual, it is virtually certain that the individual was the source of the specimen. Stated differently,

⁷ LaRue explained that the probability that a particular repeat frequency will occur at a particular locus is set by a database created by the FBI from random sampling of a large number of individuals of diverse ethnic backgrounds. This database has been published, peer reviewed by the scientific community, and accepted worldwide.

⁸ LaRue testified that sometimes DNA degrades in a sample and it is not possible to examine all thirteen loci. If, for instance, it is only possible to generate a six-loci profile, then the probability of a match would be higher, the product of six individual probabilities instead of thirteen.

if there is a full profile match, the probability that the specimen came from someone else is so remote as to be negligible; identity is established. Because autosomal STR DNA testing provides a high probability of identifying an individual as the DNA source, it is the preferred method of analysis.

Autosomal STR DNA analysis is problematic, however, when forensic scientists are confronted with a mixed DNA sample. For example, blood stains found at a crime scene may be the result of bleeding by both the victim and the perpetrator. An autosomal STR DNA profile generated from the stains will have a combination of both individuals' DNA patterns and it is not possible to attribute which traits go with which person. Further, one individual's profile often overwhelms the other and renders it un-detectible. When one individual is male and one is female, however, it is possible to perform a Y-STR DNA analysis and focus solely on the DNA of the male. Thus, the strength of Y-STR DNA testing derives from the fact that only males have a Y chromosome. Unfortunately, that fact is also the source of the test's weakness.

Because only males possess Y chromosomes, a mother does not contribute to the genetic code of her son's Y chromosome. The DNA sequence on the Y chromosome is passed in complete form from grandfather, to father, to son and on down the male lineage.

The Y chromosome loci are not independent of one another and there is no recombination of DNA. It is strictly a male marker and there is no randomness on the chromosomes. Consequently, the product rule used to generate probabilities for autosomal STR DNA analysis is inapplicable to Y-STR DNA analysis. In other words, barring random mutations, all men in a paternal lineage will possess the same Y-STR DNA profile. Thus, fathers, sons, brothers, uncles, and paternal cousins cannot be distinguished from one another through a Y-STR DNA profile.

For this reason, Y-STR DNA testing has limited usefulness in positively identifying an individual. The testing is extremely useful, however, in excluding someone since an individual cannot be the source of the DNA if the profiles do not match. If the Y-STR DNA profiles do match, then all that can be said is that the individual cannot be excluded as the DNA donor.

Because the product rule is inapplicable, the State Police Laboratory uses the "counting method" to convey the odds that the Y-STR DNA profile of any one individual would coincidentally match the profile obtained from a crime scene specimen. The State Police Laboratory has access to a database of 3561 Y-STR DNA profiles of randomly selected individuals. When a Y-STR DNA profile is generated from a crime scene specimen, the database

is searched to determine if that profile has ever been seen before. The laboratory report will then state whether the profile was found in the database, and if so, how often it occurred. The frequency of the occurrence of any particular Y-STR DNA profile in the general population, however, cannot be estimated from this information since the very next person sampled could have that profile. Thus, although Y-STR DNA analysis can detect a match with one hundred percent certainty, the match itself can only be interpreted as indicating that the individual cannot be excluded as the sample donor.

Reliability of Y-STR DNA Testing

Based on the record developed before the trial court, we are satisfied that there is a general acceptance of Y-STR DNA analysis in the scientific community. The State's duly qualified expert in the field explained the theoretical basis of Y-STR DNA analysis, the methodology used by the testing laboratory, the SWGDAM standards that govern DNA testing, and the validation procedures associated with those standards. The State Police Laboratory uses a commercially available testing kit to conduct Y-STR DNA analyses and Y-STR DNA profiles are maintained in a national database.

LaRue's testimony established that Y-STR DNA analysis is a "non-experimental, demonstrable technique" that is widely

accepted by forensic scientists. Harvey, supra, 151 N.J. at 171. The scientific basis of Y-STR DNA analysis is sufficient to prove that the technique produces uniform and reasonably reliable results. Kelly, supra, 97 N.J. at 210. LaRue's testimony thus satisfied the first prong of the Harvey test.

In the interest of completeness, we also note that the State proved the reliability of the Y-STR DNA technique under the second prong of the test, which allows a proponent to establish general acceptance "by authoritative scientific and legal writings indicating that the scientific community accepts the premises underlying the proffered testimony." Harvey, supra, 151 N.J. at 170. Here, the State submitted numerous textbooks and scholarly articles concerning the development and use of Y-STR DNA analysis. These materials set forth the theory of Y-STR DNA analysis and explained the various testing techniques.

Jobling and Gill's article is among the more informative of the State's sources. Mark A. Jobling & Peter Gill, Encoded Evidence: DNA in Forensic Analysis, 5 Nature Reviews - Genetics 739 (Oct. 2004) available at http://www.denverda.org/DNA_Documents/NRG.forensics.pdf. As explained by the authors, Y-chromosomal analysis as a specific type of STR testing allows for evaluation of male-female body fluid mixtures and the

technique is effective even in mixtures with a 4000-fold excess of female DNA. Id. at 746. They conclude that the forensic use of Y-STR analysis will continue to increase, aided by the availability of standardized commercial kits. Id. at 747.

In Paul C. Giannelli & Edward J. Imwinkelried, 2 Scientific Evidence § 18.03 at 33-34 (4th ed. 2007), the authors observe that since its initial recognition in 1996, STR analysis has become the dominant DNA typing methodology. They explain that the Y-STR test is "generally similar to the method employed in conventional autosomal STR analysis," but note that the rarity of Y-STR profiles has not yet been determined from empirical studies. Id. at 44.

In Benjamin E. Krenke et al., Validation of a Male-Specific, 12-Locus Fluorescent Short Tandem Repeat (STR) Multiplex, 148 Forensic Sci. Int'l 1, 2 (2005), the authors state that "short tandem repeat (STR) analysis is the primary technology for genetic human identification" and that Y-specific analysis is a valuable tool in criminal investigations. They discuss standards established by the Director of the FBI and SWGDAM for Y-STR DNA analytical methods and set forth a study of the "consistency and robustness" of one particular technique, the "PowerPlex® Y System." Ibid. They conclude that Y-STR DNA

analysis is reliable when used for forensic human identification. Id. at 13.

A similar conclusion was reached by researchers investigating the Y-PLEX™6 and Y-PLEX™5 genotyping systems for forensic casework. Sudhir K. Sinha et al., Utility of the Y-STR Typing Systems Y-PLEX™6 and Y-PLEX™5 in Forensic Casework and 11 Y-STR Haplotype Database for Three Major Population Groups in the United States, 49(4) J. Forensic Sci. 1 (July 2004) available at <http://www.hartnell.cc.ca.us/faculty/jhughey/Files/y-plexgenetics.pdf>. They state that these techniques provide reliable and probative results that could not be achieved through the analysis of autosomal STRs. Id. at 9.

By contrast, defendant has not cited any scientific study that questions the validity and/or reliability of Y-STR DNA analysis. The State's proffer of authoritative sources concerning the scientific basis for Y-STR DNA analysis thus demonstrates that the Y-STR technique has been generally accepted in the scientific community.

V

Having determined the general acceptability of Y-STR DNA analysis, we must next consider defendant's argument that such evidence is not probative on the question of whether he was the person who murdered his wife. Specifically, defendant argues

that the State cannot prove that he was the source of the DNA material recovered from under decedent's fingernails.

We are satisfied that this evidence is relevant and has probative value because it shows that defendant could not be excluded from the class of individuals who could have "contributed" this biological material. Thus, although this evidence cannot unequivocally establish that defendant was the person who killed his wife, it does show that defendant cannot be excluded from the class of individuals who could have been the killer.

Relevant evidence is that which has "a tendency in reason to prove or disprove any fact of consequence to the determination of the action." N.J.R.E. 401. "In determining whether evidence is relevant, the inquiry focuses upon 'the logical connection between the proffered evidence and a fact in issue.'" Verdicchio v. Ricca, 179 N.J. 1, 33 (2004) (quoting State v. Hutchins, 241 N.J. Super. 353, 358 (App. Div. 1990)). If evidence supports the existence of a specific fact, even obliquely, it is relevant. Verdicchio, supra, 179 N.J. at 34.

Here, the State's forensic expert, Christopher Szymkowiak, testified that a sample obtained from the fingernail clippings of decedent's right hand yielded a mixture of male and female DNA. Y-STR DNA analysis of the male component of the mixture

produced a profile that matched the profile developed from defendant's control sample. According to Szymkowiak, this particular profile did not match any profile recorded in the Applied Biosystems Yfilter Database of 3561 individuals.

This evidence is thus relevant in establishing that defendant cannot be ruled out as his wife's killer. This scientific conclusion is a key part of the State's case when considered in light of the totality of the evidence presented against defendant. Specifically, Susan was manually strangled; defendant had wounds on his right hand. Although Susan and defendant were married, they had not been intimate for some time. The fact that Susan had DNA under her fingernails that links defendant, by way of inclusion in the class of potential killers, justifies a reasonable inference that Susan scratched defendant while trying to remove his hand from her throat. The fact that Szymkowiak could not say with certainty that defendant was the source of the DNA does not render the test results irrelevant. Although all males in a paternal lineage share the same Y-STR DNA, and even seemingly unrelated individuals can have the same Y-STR DNA profile, there are still sufficient variations within the population to make any particular profile distinct.

In that sense, Y-STR DNA matches are analogous to several conventional forms of evidence that are routinely admitted at criminal trials. In State v. Swint, 328 N.J. Super. 236, 252-53 (App. Div.), certif. denied, 165 N.J. 492 (2000), we concluded that a box-cutter found in the defendants' possession within eight hours of an assault in which the victim was severely cut was relevant because it "had a tendency in reason to prove a fact of consequence." There had been no showing in Swint that the defendants' box-cutter was unique in any way; in fact, there was no proof that a box-cutter was the weapon used in the assault. Id. at 251. There was also no testimony concerning how many other individuals in the area might have owned a box-cutter. We noted, however, that the State's failure to provide a specific link between the evidence and the crime went to the weight of the evidence, not its admissibility. Id. at 252.

In fact, shoe imprint evidence provides the best analogy to Y-STR DNA evidence. Our courts have long admitted evidence connecting shoe imprints found at a crime scene with shoes found in a defendant's possession, despite the fact that any number of persons might own identical pairs of shoes. See, e.g., State v. Johnson, 120 N.J. 263, 293-95 (1990) (upholding the admission of lay testimony that a footprint found at the crime scene had been made by the defendant's sneaker); State v. Gerald, 113 N.J. 40,

53-54 (1988) (recounting trial testimony that the pattern on the defendant's sneakers matched imprints found on the victim's forehead); State v. Bruzzese, 94 N.J. 210, 215 (1983) (recounting trial testimony regarding the similarity between an imprint on the victim's door and a boot found in the defendant's room), cert. denied, 465 U.S. 1030, 104 S. Ct. 1295, 79 L. Ed. 2d 695 (1984). In all of these cases, the State was not required to prove that the defendant's shoes were the only ones that could have made the impressions found at the crime scene. Instead, the courts left to the jury the task of weighing the probative value of the evidence that the defendant possessed shoes identical to those used in the crime.

Here, Y-chromosome DNA with a specific STR profile was found under decedent's fingernails. The coincidence that this profile matches that of defendant is probative of his guilt in the same manner as if he had owned shoes that matched a foot imprint found at the crime scene. It was up to the jury to weigh the probative value of that evidence in light of the fact that a significant number of other individuals may possess the same profile.

Reversed and remanded. We do not retain jurisdiction.

I hereby certify that the foregoing
is a true copy of the original on
file in my office.


CLERK OF THE APPELLATE DIVISION