

Court of Appeals of Arizona,
Division 1, Department C.
STATE of Arizona, Appellee,

v.

Mark Alan BOGAN, Appellant.
No. 1 CA-CR 93-0453.

April 11, 1995.

As Corrected April 13, 1995.
Review Granted Nov. 21, 1995.

Grant Woods, Atty. Gen. by Paul J. McMurdie, Chief Counsel Criminal Appeals Section, Galen H. Wilkes, Asst. Atty. Gen., Phoenix, for appellee.

Dean W. Trebesch, Maricopa County Public Defender by James H. Kemper, Deputy Public Defender, Phoenix, for appellant.

OPINION

McGREGOR, Judge.

Mark Alan Bogan (appellant) seeks to reverse his conviction and sentence for murder in the first degree under Arizona Revised Statutes Annotated ("A.R.S.") section 13-1105.A.1. The primary issue on appeal is whether the trial judge erred in permitting expert testimony that deoxyribonucleic acid (DNA) test results indicated that two palo verde pods found in appellant's truck "matched" a palo verde tree growing at the crime scene. For the reasons that follow, we affirm appellant's conviction and sentence.

I.

On Sunday morning, May 3, 1992, Tim Faulkner was riding his dirt bike in a remote area of western Maricopa County known as the Caterpillar Proving Grounds. As he rode through a dry wash near the intersection of Jackrabbit Trail Drive and Indian School Road, he saw the nude body of a woman, lying face down in the brush near a cluster of palo verde trees. She appeared to be dead. Faulkner rode home and telephoned police.

Officers of the Maricopa County Sheriff's Office soon arrived at the site and began an investigation. Police identified the woman as Denise Johnson of Phoenix and determined she had been strangled to death. Johnson's death appeared to be recent because blood found on her body was still wet. Her clothing was scattered around the immediate area, and the matted condition of the grass suggested that she had been dragged a short distance to the spot where she was found. A cloth was tied around her neck and left wrist, a shoelace was tied around her left ankle, and braided wire was tied around her right wrist and right ankle. A vinyl strap and another braided wire were lying across the victim's

neck but not connected to anything. The unconnected length of braided wire was attached to a metal ring.

As police probed the area looking for evidence, Chad Gilliam approached and told them that he wanted to make a statement. Gilliam stated, and later testified at trial, that he had been driving home from a party at approximately 1:30 that morning when he noticed a vehicle exiting the Caterpillar Proving Grounds. The vehicle drove out of the proving grounds, ran a stop sign, turned south on Jackrabbit Trail Drive¹ and moved "pretty quick" toward Interstate 10. He paid particular attention to the vehicle because of the late hour. The vehicle was a white "dually"² pickup truck with amber clearance lights on the top of the cab.

During their search of the area for evidence, the police found a pager a few feet from the body. Police ascertained that the pager was registered to Earl Bogan (appellant's father) but used primarily by appellant.

Appellant drove a white dually pickup truck with amber clearance lights on the top of the cab. Police impounded and searched appellant's truck pursuant to a warrant. In the bed of the truck, they found two seed pods from a palo verde tree and collected them as evidence.

Appellant lived in an apartment at Eighty-third Avenue and Indian School Road, an eighteen minute drive from the Caterpillar Proving Grounds. Rebecca Franklin, who lived with appellant at the time of the crime, testified that appellant had been drinking heavily during the evening of May 2, 1992, when she left the apartment at approximately 8:30. When she returned at 11:30 that night, he was gone. Appellant awakened her at 2:03 on the morning of May 3, 1992. After Franklin noticed scratch marks on appellant's face that had not been there earlier in the evening, he told her he had received the scratches in a fight at a bar.

Franklin testified at trial that she saw a length of braided wire with a metal ring attached to it in appellant's truck sometime in late April or early May 1992. The police did not find the wire when they searched the truck on May 5, 1992.

When the police investigation focused on appellant, his version of the facts changed. He admitted lying to Franklin about his activities on the night in question. He told police that he had picked up a female hitchhiker late in the evening on May 2, 1992. His description of the hitchhiker fit the appearance of Denise Johnson.

According to appellant, he and the hitchhiker had sexual intercourse in the cab of his truck while parked behind a building somewhere along Thirty-fifth Avenue between Camelback Road and Interstate 10. Afterward, as they drove south on Thirty-fifth Avenue toward the interstate highway, they argued. Appellant stopped the truck and told the hitchhiker to get out. She then "swiped" his wallet, pager, and other items from the dashboard of the truck and ran away. He chased her down, and she scratched his face when he fought with her to recover his property. He thought that he had recovered all his

belongings but noticed the next morning that his pager was missing. Although appellant was familiar with the Caterpillar Proving Grounds, he maintained that he had not been there in years. He steadfastly denied killing Johnson. Appellant repeated this latter version of the facts when he testified at trial.

Detective Charlie Norton worked on the Johnson homicide investigation. At the crime scene, Norton observed that one of the palo verde trees--a tree later designated as "PV-30"--had a fresh abrasion on one of its lower branches. Norton contacted Dr. Timothy Helentjaris, a professor of molecular genetics at the University of Arizona, hoping that Helentjaris could use his knowledge of DNA technology to determine whether the seed pods found in appellant's truck came from one of the palo verde trees at the crime scene.

Helentjaris employed randomly amplified polymorphic DNA (RAPD) procedures to compare the DNA of the seed pods found in the truck with the DNA in seed pods from the palo verde trees at the crime scene. He also analyzed DNA from other palo verde seed pods collected at various sites around Maricopa County. He concluded on the basis of his experiments, and later testified at trial, that he was confident the seed pods found in the truck originated from PV-30.

The jury convicted appellant of murder in the first degree. The trial court sentenced appellant to life imprisonment pursuant to A.R.S. section 13-703. Appellant filed a timely notice of appeal. This court has jurisdiction to adjudicate this appeal pursuant to Ariz. Const. art. VI, section 9 and A.R.S. sections 12-120.21.A.1, 13-4031, and 13-4033.

II.

A.

The first issue appellant raises is whether the trial court erred in admitting Rebecca Franklin's testimony over appellant's objection. Appellant asserted that because he and Franklin were married on July 11, 1991, the court should preclude Franklin's testimony on the basis of the anti-marital fact privilege. See: A.R.S. S 13-4062.A.1.

To overcome appellant's claim of privilege, the state had the burden to show that appellant's marriage to Franklin was void. See: *Wilson v. Wilson*, 1 Ariz.App. 77, 81, 399 P.2d 698, 702 (1965). At trial, Teresa Bogan testified that she and appellant had married in 1982 and were still married. Appellant did not controvert Teresa Bogan's testimony, and Franklin testified for the state.

Teresa Bogan's testimony was sufficient to establish the invalidity of appellant's second marriage³, *Roy v. Industrial Comm'n*, 97 Ariz. 98, 100, 397 P.2d 211, 213 (1964) (evidence in opposition to presumption of marriage need not be conclusive). Teresa Bogan was competent to testify, and did testify, that she was still married to appellant. Appellant's marriage to Rebecca Franklin therefore was bigamous, and bigamous marriages are void ab initio. *Depper v. Depper*, 9 Ariz.App. 245, 247, 451 P.2d 325, 327 (1969) ("[W]here two individuals enter into a marriage, and where one of them, or both, has a spouse then living and from whom no divorce has been obtained, then the

subsequent marriage is void, a nullity."). Appellant offered no contrary evidence. Accordingly, the anti-marital fact privilege set forth at A.R.S. section 13-4062.A.1 did not apply to bar the testimony of Rebecca Franklin. The trial court correctly denied appellant's motion.

B.

The next issue appellant raises is whether the trial court erred in finding that RAPD technology is generally accepted by the scientific community. Prior to trial, the state and appellant each moved for a *Frye*⁴ hearing to determine the admissibility of the state's DNA evidence. The trial court conducted a four-day hearing at which three experts testified concerning the status of RAPD technology. The trial court found that RAPD technology is generally accepted in the scientific community and permitted the state's expert to testify regarding the RAPD tests he performed on the DNA from the palo verde trees.

Under *Frye*, expert testimony is admissible only if the proponent can first demonstrate that the underlying scientific principle from which the expert's deductions are made has "gained general acceptance in the particular field in which it belongs." 293 F. at 1014. The purpose of the *Frye* hearing is to resolve the "general acceptance" issue prior to trial. If the issue is resolved in the proponent's favor, the proffered expert testimony is admissible, subject to a foundational showing. *State v. Bible*, 175 Ariz. 549, 579, 858 P.2d 1152, 1182 (1993), cert. denied, 511 U.S. 1046, 114 S.Ct. 1578, 128 L.Ed.2d 221 (1994).

We review de novo the trial court's finding that a scientific principle is or is not generally accepted in the relevant scientific community. *Id.* at 579, 858 P.2d at 1182. An elementary understanding of DNA and related technology is essential to that review.⁵

1.

DNA is the genetic material in all living cells; its structure encodes hereditary information. DNA molecules are long chains made up of nucleotides, each of which contains one of four nitrogenous bases: adenine, guanine, cytosine, or thymine. Each base is paired with another in a complementary strand of DNA to form a double helix. Adenine always pairs with thymine; cytosine always pairs with guanine. The sequence of these base pairs in a DNA molecule accounts for the individual distinctions among organisms. Human DNA molecules have some three billion base pairs in a distinct sequence. Our ability to distinguish one person's DNA from another's, on a molecular level, depends on the sequence variation of the nitrogenous bases. The level of sequence variation is relatively low in humans: more than 99 percent of the nucleotide sequence in DNA molecules is identical (isomorphic) from person to person; the remaining percentage of the nucleotide sequence is varied (polymorphic) from one person to the next.

Forensic technology geared to matching the DNA from one specimen to another depends on establishing the absence of variation between the specimens. Restriction fragment length polymorphism (RFLP) testing utilizes commercially available "restriction" enzymes that bacteria produced and that have ultraspecific DNA sequence recognition functions. They target one specific sequence of nucleotide bases between four and nine base pairs in length. A restriction enzyme reads every base pair in the DNA molecule and cuts the molecule wherever the targeted sequence variation appears. The result is a set of DNA fragments varying in length (restriction fragments).

The fragments are sorted in a process known as gel electrophoresis and graphically represented in an autoradiogram, which resembles a bar code. Differences in the autoradiogram reflect differences in the DNA. Because the sequence of DNA nucleotides is identical from cell to cell in one organism, but unique from organism to organism,⁶ RFLP technology can provide conclusive proof that a sample specimen of DNA does not come from a particular organism.

However, the converse cannot be conclusively proven: seemingly identical autoradiograms could be the product of a random match, an instance in which DNA from two different organisms cannot be distinguished by employing restriction enzymes. Scientists have discovered only a limited number of polymorphic DNA sequences and have developed a lesser number of restriction enzymes. Until such time as every sequence variation in a DNA molecule is mapped and detectable for purposes of comparison, the DNA of two different organisms theoretically might be mistaken for each other in an RFLP test. The correct method of calculating the statistical probability of a random match in an RFLP test is a matter about which the scientific community has yet to reach a general consensus.⁷ Accordingly, in Arizona the *Frye* doctrine precludes trial testimony--even by statisticians--on that issue. *Bible*, 175 Ariz. at 587, 858 P.2d at 1190.

No DNA mapping has been done for most plant species, including palo verde trees. Accordingly, RFLP cannot be used to test for a match of palo verde DNA samples unless and until palo verde DNA is studied and a sufficient number of polymorphic sequences are isolated to render a meaningful test result.⁸

2.

Dr. Helentjaris used RAPD, a DNA technology related to but distinct from RFLP, to link the seed pods found in appellant's truck with a tree at the crime scene. RAPD was developed in the late 1980s and was first described in scientific journals in 1990. The original testing protocols published by DuPont Laboratories, a principal developer of the technology, have become the industry standard for RAPD technology. We are aware of no reported cases in which RAPD technology has been used for forensic purposes. RAPD applies polymerase chain reaction (PCR) technology to detect distinctions in DNA samples.⁹ PCR is a method by which DNA is alternately heated and cooled under controlled conditions to exponentially reproduce, or "amplify," it. Heating the DNA causes the two strands of the DNA molecule to separate. The DNA polymerases, which synthesize a copy of DNA when cells divide, bind to each strand and synthesize a new

complementary strand at the lower temperature. The result is two DNA molecules identical to the first double-stranded template molecule. The heating/cooling cycle is repeated thirty to forty times, doubling the amount of DNA in each cycle.

RAPD utilizes primers--randomly selected short sequences of base pairs-- that bind to their homologues on the DNA strand at the beginning of the chain reaction, greatly amplifying those segments in comparison with the rest of the DNA molecule. Each primer creates a distinctive amplification pattern consisting of variously sized fragments of the DNA molecule. Particularly distinct fragments are chosen as "markers" and used as data points to compare one specimen with another. The presence or absence of a particular marker distinguishes one specimen's DNA from that of another. Depending on the amount of sequence variation in the species being tested, distinguishing one specimen from another using very few primers may be possible.

3.

The three experts who testified at the *Frye* hearing, including appellant's expert, apparently agreed that the scientific principles underlying RAPD technology are valid. Dr. Helentjaris testified that RAPD was "obviously accepted in the [scientific] community now as a valid technique" and that RAPD technology is not the subject of debate. Dr. Stephen Smith, another expert called by the state, confirmed Helentjaris' testimony in this regard, and both Helentjaris and Smith testified to RAPD's widespread use in university laboratories and in commercial applications. Dr. Paul Keim, appellant's expert, acknowledged that many laboratories (including his own) use RAPD technology, although he criticized its relative reliability as compared with RFLP technology.

Nothing in Dr. Keim's testimony at the *Frye* hearing refuted the state's evidence that RAPD has been generally accepted as sound technology in the relevant scientific community. Moreover, Keim's testimony supports the conclusion that Helentjaris used the correct procedures in performing his RAPD analysis of the palo verde samples. Keim confirmed that Helentjaris' test "appeared to be done well"; that he had used a sufficient number of markers and did the match correctly; that the test supported the conclusion that patterns from PV-30 and patterns from the seed pods found in the truck are a "match"; and that the results of Helentjaris' tests are reliable. We conclude the trial court did not err in admitting evidence of Dr. Helentjaris' RAPD testing.

C. 1.

Appellant argues next that the trial court erred in permitting Dr. Helentjaris to express his opinion that the DNA from the seed pods found in the truck "matched" the DNA from a palo verde tree at the crime scene.

During the *Frye* hearing, Dr. Helentjaris testified that the odds of a random match in this case are one in a million. Dr. Keim, on the other hand, estimated the chance of a random match at one in 136,000. The trial judge found that the state failed to demonstrate any

agreement in the scientific community for a method of quantifying the results of Dr. Helentjaris' test and, anticipating the holding in *Bible*, ruled inadmissible statistical evidence as to the probability of a random match.

The trial court also found, however, that the only disputed issue between the expert witnesses involved the weight to be given the test results and therefore permitted Dr. Helentjaris to testify concerning his conclusions. At trial, Helentjaris testified that the two seed pods "were identical"; that he "felt quite confident in not only concluding that these two samples [of seed pods found in the truck bed] were consistent with originating from tree 30, but most likely did come from that tree"; that the samples from the truck bed "matched" PV-30 on a molecular, DNA level; that the samples "matched completely with ... PV-30" and "didn't match any of the [other] trees"; that he felt "quite confident in concluding that these two samples ... most likely did come from [PV-30]"; and that he was "quite comfortable" in concluding that PV-30's DNA would be distinguishable from that of "any tree that might be furnished" to him.

Appellant argues that Dr. Helentjaris should not have been permitted to express these opinions because, in the absence of testimony establishing the statistical probability of a random match--testimony prohibited under the holding in *Bible*--Helentjaris' opinion of a match was "meaningless" and unduly prejudicial to his case. We disagree.

Dr. Helentjaris performed RAPD testing on the seed pods found in appellant's truck bed using the standard protocols DuPont developed and scientists in the field have modified. As it happens, palo verde trees exhibit considerable sequence variation, which facilitated the RAPD testing. Helentjaris first determined that the two seed pods from the truck had the same DNA structure, indicating that they fell from the same tree, a palo verde of the *cercidium floridum* variety.¹⁰ He then analyzed the DNA from the twelve palo verde trees at the crime site, including a sample from PV-30. He was able to distinguish all twelve samples from one another using only two primers. Ultimately, he used seven primers to create forty-seven markers and tested DNA from twenty-eight palo verde trees of the *cercidium floridum* variety.

Dr. Helentjaris conducted "blind" tests: he was not informed, until after his tests were completed and his report written, which samples came from the tree with the abrasion. After testing the twelve samples from the crime site, Helentjaris tested samples from nineteen more *floridum* trees collected from various parts of Maricopa County. One of those samples, designated sample 1092, also came from PV-30. Helentjaris was not informed that the later samples contained material from PV-30, but his test results showed that the DNA from sample 1092 matched the DNA from PV-30. Helentjaris' tests distinguished the DNA from the seed pods in the truck bed from the DNA of all twenty-eight trees except PV-30. The tests that Helentjaris performed provide an adequate foundation for his opinion that the seed pods found in appellant's truck bed came from PV-30.

If Dr. Helentjaris had presented expert testimony on any subject other than DNA, we would conclude our analysis at this point and find that his opinion evidence was relevant and admissible. However, the holding in *Bible* requires us to extend our scrutiny of this issue.

In *Bible*, the Arizona Supreme Court determined that RFLP is generally accepted in the scientific community. 175 Ariz. at 582, 858 P.2d at 1185. The *Bible* court also found, however, no general acceptance in the relevant scientific community for the calculations used to determine the statistical probability of a random match of the DNA. Consequently, the court held that these calculations are inadmissible. Although this case involves RAPD, not RFLP, the statistical probability arguments raised in *Bible* apply with equal force here. The issue left unresolved in *Bible*, and squarely presented here, is whether "the inadmissibility of the random match probability calculations means that other DNA evidence, such as evidence of a match, is inadmissible." *Id.* at 590, 858 P.2d at 1193.

Courts in other jurisdictions differ widely in their approach to admitting DNA evidence. *Id.* at 587, 858 P.2d at 1190. Some courts have excluded DNA evidence altogether, pending satisfactory resolution of the statistical issue in the scientific community. See, e.g., *California v. Barney*, 8 Cal.App.4th 798, 10 Cal.Rptr.2d 731, 742 (1992); *Nelson v. Delaware*, 628 A.2d 69, 75 (Del.1993); *Massachusetts v. Lanigan*, 413 Mass. 154, 596 N.E.2d 311, 314 (1992). Some have excluded statistical evidence and opinion testimony of a match. See, e.g., *Vandebogart*, 616 A.2d at 494 (evidence of a "match" must be "accompanied by population frequency estimate that has been produced from a generally accepted method"). Another approach is to exclude only the statistical evidence. See, e.g., *Pennsylvania v. Crews*, 536 Pa. 508, 640 A.2d 395, 402 (1994) (prohibiting statistical evidence of random match while permitting testimony that it was "more probable than not" that DNA in sample matched appellant's DNA). Finally, a number of decisions hold that the validity of an expert's statistical calculations goes to the weight rather than the admissibility of such evidence. *Jenkins v. Indiana*, 627 N.E.2d 789, 795 (1993); *Minnesota v. Bloom*, 516 N.W.2d 159, 160 (Minn.1994) (admitting statistical probability evidence based on the "interim ceiling method"); *New Mexico v. Anderson*, 118 N.M. 284, 294, 881 P.2d 29, 43 (1994); *New York v. Wesley*, 83 N.Y.2d 417, 611 N.Y.S.2d 97, 101, 633 N.E.2d 451, 455 (1994). The decision in *Bible* forecloses the last approach.

A different panel of this court recently addressed the issue whether, in the absence of generally accepted population frequency statistics for calculating the probability of a random match, expert testimony that a declared "match" of DNA samples uniquely identified the defendant as the assailant is admissible. See *State v. Hummert*, 183 Ariz. 484, 905 P.2d 493 (App.1994). *Hummert* held that the trial court erred in admitting expert testimony of a "match" in the absence of generally accepted population statistics for determining the probability of a random match. *Id.*¹¹

We disagree with the holding in *Hummert*. By concluding that, absent generally accepted statistics of a random match, expert opinion testimony overstates the significance of DNA test results, *Hummert* treats DNA evidence as being unique from other types of

scientific evidence that are routinely admitted into evidence.¹² We think that holding extends beyond that required by *Bible* and fails to recognize that "neither logic nor authority supports confining ourselves to a snapshot, rather than viewing the motion picture, of technological advancement." *Bible*, 175 Ariz. at 586 n. 33, 858 P.2d at 1189 n. 33.

Rather, we conclude that the soundest approach to this issue consistent with *Bible* is to permit expert testimony on the ultimate scientific issue at hand: whether one sample is the genetic match of another. We base this conclusion on the countless reported cases in which experts declared a match in parallel circumstances without even addressing the statistical possibility of a random match. See, e.g., *State v. Atwood*, 171 Ariz. 576, 640, 832 P.2d 593, 657 (1992), cert. denied, 506 U.S. 1084, 113 S.Ct. 1058, 122 L.Ed.2d 364 (1993)(no abuse of discretion in admitting expert testimony by accident reconstructionist, who admitted he was not a "paint expert," that there was a "perfect paint match" between the paint smear on defendant's bumper and the color of the paint on the victim's bike); *State v. Dixon*, 153 Ariz. 151, 155, 735 P.2d 761, 765 (1987) (tracker properly testified that appellant's shoes matched tracks left in dirt at crime scene); *State v. Lane*, 72 Ariz. 220, 226, 233 P.2d 437, 440 (1951) (ballistic expert properly testified that fatal shots were fired from rifle that appellant had borrowed day before shooting); *Moon v. State*, 22 Ariz. 418, 423, 198 P. 288, 290 (1921) (fingerprint experts properly testified that fingerprint lifted at crime scene came from appellant); *State v. Ferreira*, 152 Ariz. 289, 294, 731 P.2d 1233, 1238 (App.1986) (hair and fiber examiner properly testified that hairs found in victim's apartment and on appellant's clothing derived from a "common origin"); cf. *State v. Garrison*, 120 Ariz. 255, 258, 585 P.2d 563, 566 (1978) (dentist testified to an eight in one million probability that teeth marks in victim were not made by appellant); *State v. Richards*, 166 Ariz. 576, 577, 804 P.2d 109, 110 (App.1990) (dentist skilled in forensic odontology testified that bite mark on victim "was consistent with appellant's dentition"). The statistical challenge raised in *Bible* could have been raised with equal force in any of those cases. Rather than disturb substantial case law or rely on a tenuous distinction between molecular genetics and other scientific disciplines, we will treat DNA opinion evidence consistently with our treatment of other scientific opinion evidence.

Opponents of DNA match testimony are free to challenge its foundation and introduce controverting evidence, as they typically do when attacking match testimony of fingerprints, hair samples, bite marks, and other identifying phenomena. In this case, appellant attacked Dr. Helentjaris' opinion testimony at trial by raising the possibility that the seed pods were surreptitiously placed in the truck bed, by impugning Helentjaris' objectivity, by emphasizing Dr. Keim's disagreement with aspects of Helentjaris' conclusions, by challenging the adequacy of the number of samples tested, by noting the fact that the tests were not duplicated and verified, and by stressing that RAPD never before has been used in any courtroom.¹³

The *Bible* decision does not render Dr. Helentjaris' opinion testimony meaningless merely by excluding specific statistical calculations. The state used Dr. Helentjaris' testimony that the seed pods in appellant's truck probably came from PV-30 to place

appellant at the crime scene. The opinion evidence therefore was relevant because it rendered the state's proposition more probable than it would be without the evidence. Ariz.R.Evid. 401. Apart from DNA cases, we know of no instance in which a court has deemed an expert's opinion testimony inadmissible, in whole or in part, on the basis of a remote statistical possibility that the opinion might be incorrect.

Non-statistical aspects of the possibility of error were the proper subject of cross-examination. Appellant was free to introduce countervailing expert testimony concerning the match, although his own expert conceded during the *Frye* hearing that the chance of a random match in this case was one in 136,000. The concededly slight possibility of a random match in this case underscores the unfairness of precluding the opinion testimony: experts in other cases offer their conclusions in the face of far less certain odds. We see no reason to create an anomalous rule for expert opinion testimony in DNA cases. Accordingly, we find that the trial court properly permitted Dr. Helentjaris to testify to the genetic "match" between the seed pods in appellant's truck and the abraded palo verde tree at the crime site.

D.

The final issue appellant raises is whether the trial court erred in permitting Dr. Helentjaris to testify that palo verde trees are an "outcrossing" species based on information he received from a botanist. At the outset of his testing, Dr. Helentjaris consulted with colleagues at the herbarium at the University of Arizona to inquire whether the palo verde tree is an "outcrossing" or "self-pollinating" species. One of the colleagues indicated to Dr. Helentjaris that the palo verde is an outcrossing species. Dr. Helentjaris made this inquiry before he began his research because he wanted to assess the feasibility of using RAPD as a means for DNA matching of the seed pods. Isolating genetic distinctions among DNA samples in an RAPD test is easier if the samples have a high degree of sequence variation, and outcrossing varieties of plants tend to have a high degree of sequence variation in their DNA structure. At trial, Helentjaris testified, over appellant's objection, that the palo verde tree is outcrossing in nature, based on information he had learned from his colleagues at the herbarium. Appellant asserts that this statement was inadmissible hearsay and that its admission amounted to reversible error. We disagree.

We make three observations in support of our conclusion on this issue. First, all the experts stated or implied that the palo verde tree is, in fact, an outcrossing species. Appellant has yet to refute this fact, so we fail to see any potential for prejudice. Second, categorizing trees as outcrossing or self-pollinating has no bearing on the results of the RAPD tests or anyone's interpretation thereof. The sequence variation of palo verde DNA remains the same whether these plants are outcrossing or self-pollinating. Finally, the question went only to establishing foundation on the preliminary issue of how Dr. Helentjaris came to determine the usefulness of performing the RAPD analysis of the seed pods.

Moreover, the admissibility of the challenged testimony about whether palo verde trees are outcrossing or self-pollinating is an issue at the extreme periphery of this case. We cannot reasonably say that this obscure bit of testimony influenced the jury's verdict. *State v. Jackson*, 130 Ariz. 195, 197, 635 P.2d 180, 182 (App.1981) (improper admission of "one minor bit of [hearsay] evidence" in a lengthy trial was harmless and did not justify reversal). Because any error in the challenged ruling would be manifestly harmless, we find addressing the admissibility issue unnecessary.

III.

We have searched the record for fundamental error pursuant to A.R.S. section 13-4035 and have found none. For the foregoing reasons, we affirm the conviction and sentence.

EHRLICH, P.J., concurs.

WEISBERG, Judge, concurring.

I respectfully disagree with the majority's conclusion that the trial court properly admitted expert testimony describing the subject DNA samples as "identical" and "matched completely." Notwithstanding, because the admission of this testimony was harmless error, I concur in the result.

Admissibility of Expert Testimony

In *State v. Bible*, 175 Ariz. 549, 858 P.2d 1152 (1993), cert. denied, 511 U.S. 1046, 114 S.Ct. 1578, 128 L.Ed.2d 221 (1994), the Arizona Supreme Court addressed the admissibility of DNA evidence. The court first clarified that Arizona would continue to follow the *Frye*¹⁴ test in determining the admissibility of scientific testimony, rather than the relevancy standard enunciated by the U.S. Supreme Court in *Daubert v. Merrell Dow Pharmaceuticals, Inc.*, 509 U.S. 579, ----, 113 S.Ct. 2786, 2794, 125 L.Ed.2d 469 (1993). The court then applied the *Frye* test to the three step analysis¹⁵ required to interpret DNA evidence. The court concluded that step #3, the random match probability calculation, was not grounded on generally accepted scientific theory, and was therefore inadmissible. *Bible*, 175 Ariz. at 586-87, 858 P.2d at 1189-90. While the court acknowledged that the probability favoring a random match is the "telling and crucial bottom line of DNA evidence," *id.* at 582, 858 P.2d at 1185, it candidly admitted being unable to foresee what technological advances and explanatory evidence might subsequently be available. It therefore left open the question whether other types of testimony regarding the existence of a "match" would be admissible.

In *State v. Hummert*, 183 Ariz. 484, 905 P.2d 493 (App.1994), a different panel of this court held that expert testimony of the rarity of a match between questioned and known DNA samples was inadmissible because " '[t]o say that two patterns match, without providing any specifically valid estimate (or, at least, an upper bound) of the frequency with which such matches might occur by chance, is meaningless.' " *Id.* at 487, 905 P.2d at 496 (quoting National Research Counsel, *DNA Technology in Forensic Science* 9

(1992)). In *Hummert*, the expert had testified that the DNA samples matched and that such a "rare" event "uniquely identified" the defendant. The court found the introduction of this testimony even more damaging to the defendant than the random match probability statistics not allowed by *Bible*, because the expert was not merely "giving the odds" of a meaningless (or random) match, but was in fact eliminating any possibility of error by stating that the match was conclusive of identity. *Id.*

The expert testimony in the instant case mirrors that presented in *Hummert*. Here, the expert testified that the DNA sample from the PV-30 tree and the samples from the pods found in defendant's truck bed "were identical" and "matched completely." Testimony that there is at least a slight chance of error, whether the odds are 1 in 1.1 million or 1 in 136,000, certainly is less prejudicial than the conclusion that the samples are identical and originate from the same tree. The admission of this testimony runs counter to our supreme court's decision in *Bible* to limit the introduction of such evidence until its validity is established within the scientific community. Since, without the random match probability calculations, the jury does not know " 'whether the [matching] patterns are as common as a picture with two eyes or as unique as the Mona Lisa,' " *Bible*, 175 Ariz. at 581, 858 P.2d at 1184 (quoting *United States v. Yee*, 134 F.R.D. 161, 181 (N.D. Ohio 1991)), the admission of the expert's unsupported conclusions miscommunicates the true significance of the match to the jury and allows in through the back door the evidence that was found inadmissible in *Bible*. Accordingly, the expert testimony should not have been admitted.

Of course, the majority disagrees with *Hummert*, and concludes that expert testimony is admissible because such testimony is relevant, and because they do not think that "a tenuous distinction between molecular genetics and other scientific disciplines" should cause DNA opinion evidence to be treated differently from other opinion testimony that is customarily allowed to support other kinds of scientific evidence. Op. at 522. While their opinion is well-reasoned, I believe that there are several important distinctions between DNA evidence and fingerprint, shoe track, bite mark, or ballistic evidence.

First, most scientific evidence does not carry DNA's aura of infallibility. As our supreme court has cautioned, there is a substantial risk of the overweighting of scientific evidence by the jury " '[b]ecause 'science' is often accepted in our society as synonymous with truth.' " *Bible*, 175 Ariz. at 578, 858 P.2d at 1181 (quoting Morris K. Udall, et al., *Arizona Practice-- Law of Evidence* S 102, at 212 (3d ed. 1991)).

Second, the non-DNA comparisons alluded to by the majority are demonstrable in the courtroom and involve principles and procedures that are comprehensible to a jury. Since fingerprint, shoe track, bite mark and ballistic evidence are all physical comparisons, a *Frye* hearing might not even be necessary because the jury can see for itself whether the samples "match"--they do not need to rely completely on scientific interpretations. See, e.g., *State v. Richards*, 166 Ariz. 576, 578, 804 P.2d 109, 111 (App.1990) (*Frye* hearing not required where presentation is of comparative evidence by an expert).

On the other hand, to understand DNA evidence, the jury must rely totally on an expert's scientific interpretation. The highly complex nature of DNA evidence not only places it beyond the understanding of many laypersons, but, unlike other types of "matches," a juror cannot make his or her own physical comparison of the DNA samples to determine whether a "match" exists. Therefore, if an error has occurred, it cannot be discovered by a juror.

Third, unlike footprint, shoe track, bite mark and ballistic evidence, what is being challenged is not the misapplication of a reliable theory by a particular expert, but rather the validity of the underlying scientific technique itself. No one seriously challenges the scientific principles behind "matches" of fingerprints, shoe tracks, bite marks or ballistic evidence. Yet, here, concern regarding the validity of the population database used to determine the significance of a match is even more worrisome than in *Bible*, because, unlike human samples, "no DNA mapping has been done for most plant species, including palo verde trees." Op. at 519. The expert's testimony of the significance of a match was determined after testing only the 12 palo verde trees at the crime site and an additional 16 samples collected from floridum trees in various parts of Maricopa County. It is questionable whether the database in this case would allow an expert to make a reliable conclusion regarding a match.

Finally, even though the statistical possibility of a random match might not have been addressed in many cases involving physical types of matches, *id.* at 492, 905 P.2d at 501, such a challenge has been made to DNA random match probability calculations. See *Bible*, 175 Ariz. at 587, 858 P.2d at 1190 (random match probability statistics are inadmissible); cf. *State v. Garrison*, 120 Ariz. 255, 258, 585 P.2d 563, 566 (1978) (expert testimony by dentist of 8 in 1,000,000 probability that bite marks were not defendant's held admissible). The supreme court has ruled that this isolated step of DNA analysis is subject to a *Frye* test independent of the remainder of the DNA analysis. See *Bible*, 175 Ariz. at 582-87, 858 P.2d at 1185-90. Accordingly, we are not free to depart from the supreme court's conclusion that DNA evidence is to be treated differently than other scientific disciplines. See *In re Marriage of Thorlin*, 155 Ariz. 357, 362, 746 P.2d 929, 934 (App.1987) (Court of Appeals may not disregard holding of Arizona Supreme Court on purported ground that analysis supporting it is incorrect or incomplete).

In sum, until DNA analysis of the significance of a match is found to be reliable and admissible, testimony regarding a match cannot go so far as to declare the samples identical. I would therefore hold the admission of the expert testimony in this case to be error.

Harmless Error

Although the admission of the DNA testimony was error, I conclude that error was harmless in light of the overwhelming weight of the balance of the evidence against defendant. While the state has the burden of showing that an error is harmless, *Bible*, 175 Ariz. at 588, 858 P.2d at 1191, an error is harmless if the reviewing court can be confident that, beyond a reasonable doubt, the error had no influence on the jury's verdict.

Id. Furthermore, our inquiry is not whether a jury would have rendered the same verdict after a trial that did not include the error, " 'but whether the guilty verdict actually rendered in this trial was surely unattributable to the error.' " *Id.* (quoting *Sullivan v. Louisiana*, 508 U.S. 275, 113 S.Ct. 2078, 124 L.Ed.2d 182 (1993)). We therefore consider the error in light of all the evidence presented at trial to determine if it was harmless. *Id.*

The evidence against defendant included: (1) Chad Gilliam's testimony that he saw a truck similar to defendant's unusual truck leaving the proving grounds at 1:30 a.m. on the morning of the murder, which fit with defendant's arrival back at his apartment soon thereafter; (2) defendant's pager was found at the crime scene; (3) defendant admitted picking up a hitchhiker who appears to have been the victim; (4) defendant's girlfriend, Rebecca Franklin, observed a braided metal wire with a ring attached in defendant's truck and testified that the wire/ring found on the victim's body was similar; (5) defendant initially lied about his activities on the night of the murder and was unable to give a detailed account of his whereabouts; (6) defendant's face was scratched by the time he returned home in the early morning on May 3, 1992, and the victim's fingernails were broken or bent back, indicating that she probably scratched her attacker; and (7) defendant's truck contained palo verde pods, even if not DNA-matched pods.

As the supreme court found in *Bible*, despite the powerful impact of the DNA evidence, the other evidence properly admitted "points with unerring consistency to one inarguable conclusion: that [d]efendant killed the victim." *Id.* Given this unequivocal evidence, independent of the contested DNA evidence, I conclude beyond a reasonable doubt that the erroneous admission of the DNA evidence could have had no influence on the verdict of the jury in this case. Thus, the error in admitting the expert testimony on the "match" between DNA samples was harmless. I therefore agree that the verdict should be affirmed.

¹ Jackrabbit Trail Drive runs north/south at what would otherwise be designated 195th Avenue.

² "Dually" is jargon for a heavy duty pickup truck with four wheels on the rear axle.

³ Appellant implicitly conceded this point during a pretrial hearing at which the trial court asked defense counsel what proof he would consider sufficient to establish "whether or not the defendant was validly divorced from his first wife." Appellant's response was, "Simply contact the first wife and find out whether the marriage has been dissolved by her or not."

⁴ *Frye v. United States*, 293 F. 1013 (D.C.Cir.1923).

⁵ Our summary of DNA related concepts is derived from uncontested expert testimony at the *Frye* hearing and the following sources: *Bible*, 175 Ariz. at 576-77, 858 P.2d at 1179-80; *State v. Hummert*, 183 Ariz. 484, 905 P.2d 493 (App.1994); *New Hampshire v. Vandebogart*, 136 N.H. 365, 616 A.2d 483, 485-88 (1992); *New Mexico v. Anderson*, 118 N.M. 284, 881 P.2d 29, 32-34 (1994); Note, *DNA Evidence in Criminal Trials: Modifying the Law's Approach to Protect the Accused from Prejudicial Genetic Evidence*, 34 ARIZ.L.REV. 829, 832-40 (1992); 9 Encyclopedia Americana 222 (1991).

⁶ Except in the case of identical (monozygotic) twins.

⁷ The probability also varies according to the procedures and protocols that the laboratory performing the test uses.

⁸ This process would have taken several months or years, according to Dr. Helentjaris. Dr. Helentjaris also testified that RFLP was impracticable due to the limited amount of DNA that could be extracted from the seed pods found in the truck bed.

⁹ Courts in other jurisdictions have concluded that PCR technology is generally accepted in the relevant scientific community. See, e.g., *Oregon v. Lyons*, 124 Or.App. 598, 863 P.2d 1303, 1309 (1993); *Spencer v. Virginia*, 240 Va. 78, 393 S.E.2d 609, 620-21 (1990). Our supreme court left this question open in *Bible*. 175 Ariz. at 577 n. 15, 858 P.2d at 1180 n. 15.

¹⁰ Three subspecies of palo verde trees are native to Arizona, one of which is the cercidium floridum variety. All of the palo verde trees at the crime scene were the cercidium floridum type. Each variety's seed pod is readily distinguishable from that of the other two varieties.

¹¹ *Hummert* dealt with RFLP technology rather than RAPD, and the random match probability is calculated differently in an RAPD test. The random match probability in an RFLP test is extrapolated from information compiled in a population data base. The data base establishes the frequency with which a particular band on an autoradiogram appears in a subgroup of the population. Random match probability in an RAPD test is calculated using the product rule based on binary information. The data points are distinct fragments which either do or do not exist in the sample. Certainty of a match depends on the amount of sequence variation in the DNA being tested and the number of primers used, markers established, and samples tested. We cannot, however, distinguish *Hummert* from this case on that basis.

¹² *Hummert* relied on cases from other jurisdictions, including *California v. Barney*, 8 Cal.App.4th 798, 10 Cal.Rptr.2d 731 (1992). However, *California v. Wilds*, 31 Cal.App.4th 636, 37 Cal.Rptr.2d 351 (1995), criticized *Barney* and held that declaring a DNA match was admissible, notwithstanding the lack of general acceptance in the scientific community for calculating the probability of a random match.

¹³ Appellant did not conduct any independent tests on the seed pods, although half the DNA was still available. Appellant made a tactical decision not to call his own expert at trial, apparently concluding that Dr. Keim's agreement as to the reliability of the tests outweighed his difference of opinion as to the strength of the match.

¹⁴ *Frye v. United States*, 293 F. 1013 (D.C.Cir.1923).

¹⁵ 1) Creating a DNA "print" or "profile" of a sample;
2) Determining whether the prints or profiles of different samples match; and
3) If samples match, computing the probability of a random match.

Bible, 175 Ariz. at 586, 858 P.2d at 1189.