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DNA PROFILING AND THE LAW IN SOUTH AFRICA

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1 Introduction

Like latent fingerprints, our DNA[1] is an individuating factor[2] that is unique to each human being. It therefore stands to reason that the application of forensic DNA profiling is highly efficacious, along with other modes of forensic techniques, in the successful investigation of crime and the prosecution of offenders. However, DNA analyses and profiles are not always adequately understood by the legal fraternity and the perception that DNA evidence is infallible obscures many potential problems raised by the methodology and interpretation of such evidence.[3]

The aim of this article is to provide the legal community with the necessary information not only to understand the significance of DNA evidence, but also to successfully adduce, and challenge the validity of, such evidence in court. This article also outlines the interaction that exists between science and the law.

The initial collection of biological evidence from a crime scene is of paramount importance in maintaining the integrity of DNA evidence. Various aspects relating to the collection, documentation and preservation of DNA evidence are therefore outlined and evaluated.

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1 Mathews and Van Holde *Biochemistry* 6 – deoxyribonucleic acid has been proven to contain human genetic information.

2 Kiely *Forensic Evidence* 65 – individuating factors indicate a specific individual, not merely a class of persons.

3 Murphy E "The art in the science of DNA: A layperson's guide to the subjectivity inherent in forensic DNA typing" 2008 *Emory Law Journal* 58:490.

An understanding of forensic DNA profiling is dependent on knowledge of the scientific principles that underpin how DNA samples are analysed and the manner in which DNA profiles are interpreted. The methods currently employed by the Biology unit of the Forensic Science Laboratory of the South African Police Service (hereafter referred to as "the Forensic Science Laboratory") in analysing DNA evidence are thus discussed.

Shortcomings regarding the presentation of DNA evidence in court have been pointed out in case law from various jurisdictions. These shortcomings are considered and compared with recent improvements in laboratory performance and the interpretation of results. Quality control procedures are also reviewed.

The manner in which DNA evidence is interpreted and presented in court is paramount. The presentation of such evidence in court is evaluated with due regard to the principles of natural justice, fairness and scientific reliability.

2 The biochemistry of DNA

Living cells in the human body are both the smallest, irreducible units of life and the carriers of genetic material. Each cell contains a membrane-bounded, spherical body known as the nucleus.[4] It is within these nuclei that every individual's genetic material is contained in the shape of coiled rods known as chromosomes.[5] These chromosomes are thread-like structures containing linear sequences[6] of four different nucleotide bases.[7]

The normal human cell contains 46 chromosomes arranged in 23 pairs, one pair originating from each parent. The genetic material contained in these chromosomes comprises "coding" as well as "non-coding" regions.[8] The coding regions are

4 Watson *et al. Recombinant DNA* 2.
5 Watson *et al. Recombinant DNA* 2.
6 Meintjes-Van der Walt *DNA in the Courtroom: Principles and Practice* 6.
7 Adenine (A), cytosine (C), guanine (G) and thymine (T).
8 Butler *Fundamentals of Forensic DNA Typing* 23-25.

sequences of nucleotide bases that contain the information needed to produce proteins and are called "genes".[9]

The non-coding regions in a chromosome contain polymorphic DNA markers that differ greatly among individuals. Short tandem repeats (STRs) are short stretches of polymorphic DNA that are repeated many times in succession in the human genome and the variability of the number of repeats between individuals make STRs important for identification purposes.[10]

The exact location or site of either a specific gene or polymorphic marker[11] on a chromosome is called a locus.[12] A copy of a gene or DNA marker resides on the same locus on each of the chromosomes in a pair, one copy from each parent.[13]

The nucleotide sequence of each chromosome in a pair may be identical to the other, but may also differ due to mutations in the DNA. The different variations of a gene or locus are referred to as alleles. Normally, people have two alleles at a given locus and where these two alleles are identical to the other, they are homozygous, and where they are different, they are said to be heterozygous.[14]

The description of alleles present at a specific locus is known as a genotype. The combination of several genotypes from multiple loci forms the DNA profile of an individual.[15]

Humans share approximately 95 – 99 percent of their nucleotide sequences. The remainder, namely the sections of DNA that are unique to individuals (with the

9 Butler *Fundamentals of Forensic DNA Typing* 25.
10 Meintjes-Van der Walt *DNA in the Courtroom: Principles and Practice* 12.
11 Genetic markers are genes or DNA sequences with known loci on chromosomes, used for identification purposes.
12 Butler *Fundamentals of Forensic DNA Typing* 25.
13 Butler *Fundamentals of Forensic DNA Typing* 25.
14 Butler *Fundamentals of Forensic DNA Typing* 25; Meintjes-Van der Walt *DNA in the Courtroom: Principles and Practice* 6.
15 Butler *Fundamentals in Forensic DNA Typing* 25.

exception of identical twins, who have the same DNA profile), are the regions of the DNA that are used for forensic DNA profiling or typing.[16,17]

DNA testing for identification purposes is effective because the DNA profiles vary greatly among people. It is improbable (though not impossible) that two individuals will have identical combinations of genotypes at multiple loci, or DNA profiles.[18] The probability that two DNA profiles will differ depends on the number of loci analysed, as well as the rarity of the matching genotypes at each locus.[19] The higher the possible variation in DNA markers, the greater the discrimination between samples will be.

3 DNA profiling and the law

3.1 The interaction between DNA profiling and the detection of crime

Edmond Locard (1877–1966) studied the interaction between different systems and noted that every contact leaves a trace value.[20]

According to Van Niekerk,[21] the Locard Principle of cross-transfer is the basis of forensic biological analyses. What the Locard Principle means for forensic DNA testing is that an individual can, by means of analyses and the comparison of the DNA profile obtained, –

- be implicated as potentially involved in a crime or be connected to a crime scene owing to matching biological evidence, or
- be exculpated owing to his or her DNA profile differing from that of the biological material found at the scene[22]

16 Goodwin JA and Meintjes-Van der Walt "The use of DNA evidence in South Africa: Powerful tool or prone to pitfalls?" 1997 *SALJ* 114(1):153.
17 Murphy 2008 *Emory Law Journal* 495.
18 Meintjes-Van der Walt *DNA in the Courtroom: Principles and Practice* 9.
19 Meintjes-Van der Walt *DNA in the Courtroom: Principles and Practice* 9.
20 Muller K and Saayman G "Forensic science in medicine: What every doctor in SA should know" 2003 *SA Huisartspraktyk* 45(6):41.
21 Van Niekerk J "Human identification through forensic genetic typing (DNA)" 2001 *Prosecutor's Manual* 1:C10-4.
22 Murphy 2008 *Emory Law Journal* 493.

When a sample of human tissue or body fluid is collected as part of the evidence found at the crime scene, the genetic material or DNA within the sample has the potential for individual identification of the source of that sample.[23] This is known as the crime sample and is of unknown origin. The purpose of forensic analysis is to determine the identity of the depositor of that biological material. The unknown biological sample must now be compared with a biological sample of known origin, called a control or reference sample.[24]

Current testing techniques use STR markers, with each marker targeting a particular locus on the genome. STRs at a specific location on the chromosome differ among individuals according the number of times the sequence is repeated. For forensic DNA profiling purposes, loci are chosen that display considerable variability among individuals. The South African Police Service Forensic Science Laboratory employs a 10-locus STR system which means that in the course of DNA profiling, 10 loci will be analysed to generate a DNA profile which represents all of the alleles found at all of the the loci.[25]

If two DNA profiles are identical at each of the loci examined, the profiles are said to match.[26] When a DNA match has been achieved, the profiling process is by no means finalised. The DNA profile now has to be compared to a population database. What the state has to prove when advocating a DNA match is that the probability that another individual other than the accused or victim could have deposited the DNA-containing material is small enough to accept the accused (or victim as the case may be) as the only possible depositor. The significance of the match is determined by estimating the frequency with which that profile would occur at random in the population. This is called the match probability and describes the statistical probability of a randomly selected person's having a DNA profile that matches that of the crime sample.[27]

23 Kirby and Downing 1999 *Obiter* 307.
24 Van Niekerk 2001 *Prosecutor's Manual* C10-7.
25 Meintjes-Van der Walt *DNA in the Courtroom: Principles and Practice* 89.
26 Meintjes-Van der Walt 2001 *SACJ* 378.
27 Goodwin & Meintjes-Van der Walt 1997 *SALJ* 164.

Ultimately, DNA evidence depends upon statistical probability, in that the probability of two individuals sharing a DNA profile is determined by the number of loci examined. Therefore, the more loci identified the less the statistical probability that a person randomly selected, other than the person whose DNA profile matches that of a sample, was the donor of the relevant biological sample.[28]

4 Laboratory analyses of DNA evidence: The methods used

4.1 Introduction

Forensic DNA laboratories across the globe employ uniform methods and standards of DNA typing. The Forensic Science Laboratory adheres strictly to these methods and standards.[29]

The process of DNA typing commences with the extraction of the genetic material from the DNA-containing matter collected from the scene. Since the dynamics of a crime scene are not usually conducive to the collection of large quantities of DNA, amplification of available DNA using the Polymerase Chain Reaction (PCR) is routinely used to increase the amount of DNA at the relevant loci to allow for accurate DNA profiling.

4.2 Polymerase chain reaction

The polymerase chain reaction, or PCR, is a DNA amplification technique that simulates the cell replication process under controlled circumstances in the laboratory. Specific areas (loci) of DNA, which are known to vary in size among people, are targeted and copied multiple times.[30]

Meintjes-Van der Walt[31] succinctly explains the technique that is performed, in three distinct stages: first, the DNA sample is heated (to 70^{o}C) to enable the double-

28 Van Niekerk 2001 *Prosecutor's Manual* C10-2.
29 Meintjes-Van der Walt 2008 *South African Journal of Criminal Justice* 28-29.
30 Van Niekerk 2001 *Prosecutor's Manual* C10-11.
31 Meintjes-Van der Walt 2008 *SACJ* 29; Meintjes-Van der Walt *DNA in the Courtroom: Principles and Practice* 38-39.

stranded DNA helix to separate into single strands. The enzyme that is responsible for the copying of original DNA is also activated during this process.

Secondly, primers (synthesised DNA fragments bordering on the area to be duplicated) are bound to specific segments of the single-stranded DNA. These primers facilitate the duplication process and the identification of the specific locus to be copied.

Thirdly, and finally, the DNA is duplicated by an enzyme with the primes as starting point for 1 minute at 72 ^{o}C. This process is repeated several times (about 28 to 30 times) until millions of copies of the relevant regions of the initial DNA segment are created.[32]

This polymerase chain reaction amplification technique[33] has a distinct advantage in that it allows DNA typing results to be obtained using extremely small amounts of DNA from almost any nuclei-containing tissue as well as partially degraded genetic material from old or exposed samples.

Developmental validations of the different short tandem repeat–polymerase chain reaction typing kits available for forensic typing are conducted by the manufacturers of these kits. The Forensic Science Laboratory has also performed in-house validation of the "Profiler Plus" short tandem repeat–polymerase chain reaction typing kit that is currently used by the laboratory.

Positive and negative controls are used with every typing and all results are generated in duplicate before being reported. The equipment used for the amplification of the target DNA regions is called a GeneAmp polymerase chain reaction system, which is officially calibrated on a regular basis. Time and temperature are the measurement parameters on this apparatus and can be traced

[32] Meintjes-Van der Walt 2008 *SACJ* 29-30; Meintjes-Van der Walt *DNA in the Courtroom: Principles and Practice* 38-39.

[33] Goodman and Meintjes-Van der Walt 1997 *SALJ* 155.

to national standards. The equipment is serviced according to the manufacturer's instructions and the accurate functioning thereof is regularly tested.[34]

4.3 DNA analysis: Short tandem repeat typing

As previously explained, short tandem repeats refer to a sequence of bases repeated consecutively several times at a particular locus. These tandem repeats at a specific locus differ amongst individuals with reference to the number of times they are repeated.[35]

The combination of the genotypes at all of the loci analysed for forensic purposes forms the individual's unique, short tandem repeat profile.

Evett[36] explains that several loci are simultaneously amplified, using the polymerase chain reaction, and electrophoresed to determine the sizes of the short tandem repeat alleles under analysis.

Kirby and Downing[37] note that short tandem repeat analysis is an excellent marker for identification, because allele sizes vary considerably among individuals. Moreover, short tandem repeat analysis is an effective discriminating marker in population-genetics analysis, because the frequency of allele sizes varies among races and ethnic groups.

The analysts of the Forensic Science Laboratory of the South African Police Service employ the AmpFISTR Profiler Plus™ PCT Amplification Kit as their selected mode of STR DNA analysis.[38] This system is a widely accepted mode of DNA analysis and uses short tandem repeat analysis to amplify 10 different areas (loci) of DNA.[39] Nine

34 Lucassen "Structured qualitative interview".
35 Meintjes-Van der Walt 2008 *SACJ* 31.
36 Quoted in Goodwin & Meintjes-Van der Walt 1997 *SALJ* 156.
37 Kirby and Downing 1999 *Obiter* 311.
38 Meintjes-Van der Walt *DNA in the Courtroom: Principles and Practice* 43.
39 In the United States of America, 13 loci are used in DNA profiling in CODIS (Combined DNA Indexing System), and the United Kingdom also employs 10 loci examinations.

of these loci contain a short tandem repeat profile,[40] and the tenth locus, known as the amelogenin, indicates the gender.[41]

Different loci are used to produce a short tandem repeat profile, which is recorded as a series of numbers that represent the alleles at the loci being analysed. The number corresponds to the number of times a sequence is repeated at the locus under consideration.

The DNA analysis process is therefore nothing more than a process of fragment size analysis. The sizes of the alleles typed at the different DNA (short tandem repeat) loci for the crime sample are compared with the sizes of the alleles typed for the blood or buccal sample of the accused. When the sizes of the alleles correspond, a match is called between the crime sample and reference blood sample of the accused. Lucassen emphasises that it is the combination of alleles found at the different DNA (short tandem repeat) loci – and not the result of one specific DNA (short tandem repeat) locus – that makes an individual's DNA profile unique.[42]

5 DNA profiling and its presentation in court: Shortcomings and solutions

5.1 Collection of crime samples

The purpose of a crime scene investigation is to record the scene, to identify physical evidence and to collect relevant biological and other potential evidence.[43]

Within the strict procedural parameters of crime scene investigation, a variety of DNA-containing material may be present at the scene of a crime: blood, semen, hair pulp, saliva, tissue and cells, hair, bones and teeth.[44] Such evidence should be collected by appropriately trained police officers or crime scene examiners. It is the responsibility of a medical examiner to collect and preserve evidence obtained from

40 D3S1358, vWA, FGA, D8S1179, D21S11, D18S51, D5S818, D13S317 and D7S820.
41 Meintjes-Van der Walt *DNA in the Courtroom: Principles and Practice* 43.
42 Lucassen "Structured qualitative interview".
43 Van Niekerk 2001 *Prosecutor's Manual* C10-7.
44 Kiely *Forensic Evidence* 430.

the body of a victim and/or perpetrator. In cases of sexual assault, the medical examination will be focused on the mouth, anus and genitalia of the individual.[45]

Ellis[46] emphasises the importance of the correct methodology being used for the initial collection and preservation of biological material from the crime scene, stating that the methodology may become grounds for challenging the admissibility of the evidence provided in court. Although Goodwin and Meintjes-Van der Walt[47] agree that the proper collection and documentation of evidence are important, they disagree that admissibility may be affected by virtue of the fact that the methodology is challenged in court. They submit that the relevant evidence will generally be admitted in court and that the issue to be determined by the trier of fact will be the weight to be attached to such evidence.

5.2 Contamination

The sensitivity of DNA profiling makes such profiling susceptible to contamination by a variety of sources, which contamination can seriously affect the profile results.[48] PCR amplification is very sensitive to small amounts of DNA and it is vital that crime scene technicians and scientists guard against contamination during the collection and analysis of a DNA sample.[49] It is therefore essential for the prosecution to prove the chain of custody so that a foundation is properly established to connect the evidence and the accused, as well as to ensure that the evidence is what it purports to be.[50]

Van Niekerk[51] underlines the importance of evidence documentation. Nothing should ever be processed until its original condition and other relevant information have been confirmed and recorded. He explains that, if the original location, mode of collection and chain of custody of DNA evidence is not properly documented, its

45 Muller and Saayman 2003 *SA Huisartspraktyk* 43.
46 Ellis A "Baby rape: Why does the law not protect them?" 2003 *TRW* 28(1):68.
47 Goodwin and Meintjes-Van der Walt 1997 *SALJ* 168-169.
48 Kirby and Downing 1999 *Obiter* 318.
49 Butler *Fundamentals of Forensic DNA Typing* 141.
50 Meintjes-Van der Walt *DNA in the Courtroom: Principles and Practice* 14.
51 Van Niekerk 2001 *Prosecutor's Manual* C10-6.

origin may be questioned. This is because if biological evidence is improperly collected or packaged, cross-contamination or sample degradation may occur.[52]

A DNA crime sample may be contaminated at any point in the process of collection, storage and analysis. DNA-containing material may be present at a crime scene for several hours to weeks and may be exposed to contamination by various sources.[53] Contamination may also occur if samples remain in police evidence storerooms for extended periods without being adequately packaged and preserved.

Meintjes-Van der Walt[54] cautions officials collecting crime scene samples to avoid contamination as well as the mixing and/or mislabelling of samples. Kirby and Downing[55] advocate that collected samples be handled in a manner that eliminates the possibility of cross-contamination. They give the following guidelines for the collection of samples:

- Samples should always be handled with gloves to avoid contamination. Gloves should be changed between samples to avoid cross-contamination.
- Blood samples or buccal swabs should be of sufficient quality to allow duplicate testing.
- Samples should be stored as soon as possible in labelled, sealed containers and at temperatures below 4° C.
- Stained material (cloths or swabs impregnated with blood or semen) should be fully air dried before being stored.
- Samples should after collection be immediately forwarded to the forensic laboratory, where appropriate storage conditions are available.

Ellis[56] elaborates on the above list by adding that the instruments employed to collect the evidence should always be sterilised prior to their use.

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52 Van Niekerk 2001 *Prosecutor's Manual* C10-8.
53 Goodwin and Meintjes-Van der Walt 1997 *SALJ* 158-159.
54 Meintjes-Van der Walt 2000 *Tydskrif vir Regsvergelyking en Internasionale Reg van Suidelike Afrika* 351.
55 Kirby and Downing 1999 *Obiter* 316, 317 & 324.
56 Ellis 2003 *TRW* 68.

5.3 Degradation

Progressive degradation of DNA molecules begins on cell death when enzymes called nucleases start the hydrolysis of the bonds between the constituent elements making up a DNA molecule.[57] Rates of DNA degradation vary in accordance with the tissue in which it exists, and according to the condition and exposure to environmental conditions of such tissue. For example, DNA in small spots of blood exposed to air will degrade more rapidly than DNA contained in the bulb of a hair shaft or in hard tissue like bone.[58] For this reason, it is imperative that DNA-containing material be properly collected and stored under the appropriate conditions and, most importantly, that these samples not be retained in police precinct store rooms for lengthy periods.

5.4 Chain of custody: Handling the evidence

The accused, or his or her legal representative, frequently challenges the chain of custody of a sample that has undergone DNA analysis. The purpose of such a challenge is to ensure that the sample is indeed what it purports to be and that it was not intentionally or accidentally altered in any way prior to being tested.[59]

When presenting evidence, the State has to prove that the chain of custody of the sample in question was intact. Section 212(8) of the *Criminal Procedure Act*[60] authorises the submission of affidavits in which the handling of exhibits and samples is described. In such cases it may not be necessary to lead *viva voce* evidence.[61]

In *S v Van Tonder*,[62] Myburgh J held that, if the chain of custody is disputed, the state has to prove that the sample was properly sealed, that it reached the laboratory in the same condition as it was in when dispatched, and that it could not be opened without breaking the seal. If necessary, it will then be incumbent upon the state to

57 Goodwin and Meintjes-Van der Walt 1997 *SALJ* 159; Mathews and Van Holde *Biochemistry* 91.
58 Goodwin and Meintjes-Van der Walt 1997 *SALJ* 159.
59 Bronstein *Law for the Expert Witness* 100.
60 *Criminal Procedure Act* 51 of 1977.
61 Unless the defence elects to object to the submission of a s 212(8) report, in which case the state is then obliged to call the author of the report to testify to its contents.
62 1976 3 SA 391 (T).

subpoena the person who sealed, transported or received the sample to give evidence as to the correctness of the procedure.

5.5 Forensic analyses: Laboratory performance and the interpretation of results

In 2001, in *S v Maqhina*,[63] DNA evidence was brought before the court for consideration. The court held that, where an accused's guilt depends solely on the results of scientific analyses, it is of paramount importance that the testing process, including the control measures applied, be executed and recorded with such care that it can be verified at any time by an objective expert and the trial court.[64] This provision remains valuable today.

As stated previously, the polymerase chain reaction-amplification technique is an internationally accepted technique for forensic DNA typing.[65] According to Meintjes-Van der Walt,[66] the main issue dealt with in the judgment was the role of expert witnesses and the protocols that should be followed in the process of scientific analyses. Van Oosten J referred to the responsibility borne by expert witnesses towards the court and emphasised this duty, especially in circumstances where the court does not possess the expertise and facilities to draw appropriate inferences.[67]

In this case, the court held that the state had failed to prove the objective reliability of the DNA results and pointed out several shortcomings of DNA evidence. Some shortcomings still relevant today are:

- The expert of the Forensic Science Laboratory had not followed appropriate standard protocols.[68]

63 2001 1 SACR 241 (T).
64 *S v Maqhina* 2001 1 SACR 241 (T) 251H-I.
65 *S v Maqhina* 2001 1 SACR 241 (T) 249.
66 Meintjes-Van der Walt 2001 *SACJ* 380.
67 *S v Maqhina* 2001 1 SACR 241 (T) 251H-I.
68 *S v Maqhina* 2001 1 SACR 241 (T) 250F.

- The expert of the Forensic Science Laboratory had failed to run certain duplicate tests, which, according to the defence expert, made it impossible to determine the reliability of the test.[69]
- The Forensic Science Laboratory was not an accredited laboratory.[70]

Martin[71] outlines three criteria that should be met in order for forensic evidence to be accepted as reliable:

- The underlying scientific principle must be considered valid by the scientific community.
- The technique applying the scientific principle must be known to be reliable.
- The technique must be shown to have been correctly and properly applied to the case in question.

These criteria are based on the guidelines that were set out for the admissibility of scientific evidence in 1923 in the United States case of *Frye*.[72]

Martin[73] further suggests that the following requirements also be met:

- The condition of any instrumentation used must be examined.
- The person(s) conducting the tests must be suitably qualified.
- The person(s) interpreting the results must be suitably qualified.

The Australian case of *R v Chamberlain (2)*[74] illustrates the consequences of yjr use of unreliable scientific methodologies in forensic DNA analysis. The following flaws in the procedure and in the execution of scientific laboratory tests were revealed:

- A number of the scientists who carried out the tests were not sufficiently experienced or adequately supervised.

69 *S v Maqhina* 2001 1 SACR 241 (T) 251C.
70 *S v Maqhina* 2001 1 SACR 241 (T) 251C-D.
71 Martin C "DNA profiling" 1998 *De Rebus* August 68.
72 293 F.1013 DC Cir 1923; quoted in Martin 1998 *De Rebus* 68.
73 Martin 1998 *De Rebus* 68.
74 1984 153 CLR 521; quoted in Meintjes-Van der Walt 2000 *Tydskrif vir Regsvergelyking en Internasionale Reg van Suidelike Afrika* 363.

- Tests were used by the scientists without confirmatory work to verify the results.
- Test material was destroyed without the results being recorded photographically.
- Adequate controls were not used, particularly in the key area of testing Chamberlain's car for the presence of fetal blood.
- Inadequate systems were in place for the crosschecking of some of the results and procedures.
- Results were obtained from testing which should have been identified as contradictory.
- A product produced for the purpose of research was used in spite of warnings by the manufacturer that its diagnostic significance was limited.

Steventon[75] identifies another problem: research conducted in England by the subcommittees of the Royal Commission on Criminal Justice (1993) confirmed that, in most cases, the prosecution and the police are at a distinct advantage when dealing with scientific evidence such as DNA profiling. This is probably so because defence lawyers often do not have access to DNA-containing matter to conduct independent analyses in corroboration of state-produced results. Furthermore, accused persons and their legal representative often do not have the means to acquire experts of their own for both testing and consultation.

Goodwin and Meintjes-Van der Walt[76] suggest that the problem can be resolved by providing the defence with adequate resources and with accessibility to an expert. Another possible solution would be the introduction of neutral, court-appointed experts who would either be called by the court to give evidence or who would act as special assessors for the evaluation of expert evidence.

5.6 DNA databases and statistical probabilities

Weir[77] emphasises the need to establish DNA typing frequency databases that are adequately representative of all of the ethnic groups within a population so that one

75 Quoted in Cassim Y "DNA profiling: What can South Africa gain from the British experience?" 1997 *Acta Criminol* 10(1):11.
76 Goodwin and Meintjes-Van der Walt 1997 *SALJ* 170.
77 Quoted in Goodwin and Meintjes-Van der Walt 1997 *SALJ* 167.

can adequately calculate the probability of another random person in the population having the same DNA profile of the accused.

According to Koehler,[78] the following concerns successfully raised by the defence team in the American case, *People v Simpson,*[79] must be borne in mind when presenting DNA evidence:

- the reliability of the databases used to produce the DNA frequencies
- the meaning of DNA frequency statistics

Lucassen[80] states that, except in the case of identical twins, the probability of two persons having the same combination of results at all nine loci analysed in South Africa is approximately one in one billion. However, he warns that DNA evidence should never be considered separately from other evidence, even if it might have significant evidential weight owing to its statistical probability.

American Judge Harrison's[81] support for this reasoning is evident from the following concise passage:

> I should … members of the jury just sound a note of caution about the statistics. However compelling you may find those statistics to be, we do not convict people in these courts on statistics. It would be a terrible day if that were so.

5.7 Solutions to problems

5.7.1 Quality control and assurance in the laboratory

DNA profiling has revolutionised the role of science in legal decision-making. According to Meintjes-Van der Walt,[82] the validity and reliability of a specific result

78 Koehler JJ "One in millions, billions and trillions: Lessons from People v Collins (1968) for People v Simpson (1995) 1997 *Journal of Legal Education* 47:216.
79 No. BA097211, 1995 WL 704381 (Cal. Super. Ct. Oct. 3, 1995).
80 Lucassen "Structured qualitative interview".
81 *R v Clark* CA 07495Y3 (2 Oct 2000), para 128; quoted in Redmayne M "Appeals to reason" 2002 *MLR* 65(1):19.
82 Meintjes-Van der Walt 2001 *SACJ* 381.

depends on the quality control and quality assurance procedures followed in the laboratory. Quality control refers to the measures taken to ensure that the results and interpretation of a DNA result meet a specified standard of quality. Quality assurance refers to the monitoring, verifying and documenting of laboratory performance.

The guidelines set out by the groups appointed by the Federal Bureau of Investigation, such as the Technical Working Group on DNA Analysis Methods and the DNA Advisory Board concerning Documentation, Validity and Proficiency Testing, can serve as examples of measures ensuring quality assurance.[83]

In terms of these guidelines,[84] laboratories are required to document the following:

- laboratory organisation and management
- personnel qualifications and training
- laboratory facilities
- evidence control procedures
- the validation of methods and procedures
- analytical procedures
- equipment calibration and maintenance
- standards for case documentation and report-writing
- procedures for reviewing case files and testimony
- proficiency testing
- audits
- safety programmes

The Technical Working Group on DNA Analysis Methods and the DNA Advisory Board's recommendations require the documentation of procedures to ensure sample integrity and to avoid sample mix-ups, labelling errors and recording errors.

83 Meintjes-Van der Walt 2001 *SACJ* 381.

84 "Guidelines for DNA proficiency testing" (1994) – quoted in Meintjes-Van der Walt 2001 *SACJ* 381.

They also mandate case reviews in order to identify inadvertent errors before the final report is compiled.[85]

In South Africa, the South African National Accreditation System, SANAS, provides technical guidelines for forensic DNA testing laboratories.[86] The provisions contained in the guidelines are similar to those of the Technical Working Group on DNA Analysis Methods.

In terms of these guidelines,[87] laboratories are required to –

- establish and maintain a documented quality system that is appropriate to their testing activities
- ensure that laboratory personnel and the DNA technical leader have the education, training and experience commensurate with the type of examination and testimony required
- follow procedures for monitoring, cleaning and decontaminating facilities and equipment
- have, and follow, an evidence control system to ensure the integrity of physical evidence
- check, where possible, that they retain or return a portion of the evidence sample or extract
- use validated methods and procedures for forensic casework analyses
- have, and follow, general guidelines for the interpretation of data
- use equipment that is suitable for the methods employed
- conduct administrative and technical reviews of case files and reports to ensure that conclusions and supporting data are reasonable and within the constraints of scientific knowledge
- conduct audits annually in accordance with the standards outlined herein

85 Meintjes-Van der Walt 2001 *SACJ* 381.
86 SANAS (South African National Accreditation System) "Technical guidelines for forensic DNA testing laboratories" Version 4 (October 2002) 1-20.
87 SANAS "Technical guidelines for forensic DNA testing laboratories" 1-20.

According to Lucassen,[88] the Forensic Science Laboratory has subscribed to these national and international quality control protocols since the *Maqhina*[89] case, in which the reliability of the DNA results was questioned. The Forensic Science Laboratory strictly adheres to these objective laboratory procedures and all procedures are properly documented. Positive and negative controls are used with every test and, where possible, all results are generated in duplicate before being reported. As far as possible, portions of crime samples are retained to allow for reanalysis.

5.7.2 Standards for equipment and personnel

The use of precision equipment is mandatory in DNA testing and the correct calibration is paramount in ensuring accurate, reliable results. Lucassen[90] states that regular testing and official calibration of equipment form part of the Forensic Science Laboratory's quality control programme. The equipment is serviced according to the manufacturer's instructions.

Goodwin and Meintjes-Van der Walt[91] consider the use of appropriately trained personnel to be the most important factor in forensic DNA testing. Individual certification is recommended and indeed mandated by SANAS. According to Lucassen,[92] the Forensic Science Laboratory provides internal training for recruits. The training programme used complies with recognised international standards. An internal proficiency test must be successfully completed as a prerequisite to analysis of forensic samples. The personnel employed at the FSL may thus be deemed suitably qualified and the analysts are regarded as expert witnesses in their fields of expertise.

6 Presenting DNA evidence: Section 212 affidavit or *viva voce* evidence?

88 Lucassen "Structured qualitative interview".
89 *S v Maqhina* 2001 1 SACR 241 (T).
90 Lucassen "Structured qualitative interview".
91 Goodwin and Meintjes-Van der Walt 1997 *SALJ* 163.
92 Lucassen "Structured qualitative interview".

Kirby and Downing[93] state that, because of the contentious nature of DNA evidence, an understanding of DNA profiling is dependent on proficient laboratory practice and accurate interpretation by forensic experts. Schultz[94] elaborates by stating that DNA identification is based on complex and sophisticated techniques that employ statistical calculations. For these reasons, it may be difficult for people without this knowledge to assess the validity of DNA analyses.

The question that now arises is how DNA evidence should be presented in court. Can an affidavit relating to DNA analysis be tendered in court as a section 212 affidavit[95] or should expert *viva voce* evidence be presented?

6.1 Comparing the section 212 affidavit and oral evidence

Section 212(4)(a)[96] reads as follows:

> (a) Whenever any fact established by any examination or process requiring any skill –
> (i) in biology, chemistry, physics, astronomy, geography or geology;
> (ii) in mathematics, applied mathematics or mathematical statistics or in the analysis of statistics;
> (iii) …;
> (iv) …;
> (v) …;
> (vi) …
> is or may become relevant to the issue at criminal proceedings, a document purporting to be an affidavit made by a person who in that affidavit alleges that he or she is in the service of the State …, and that he or she has established such fact by means of such an examination or process, shall upon mere production at such proceedings be *prima facie* proof of such fact… .

Evidence by way of a section 212(4) affidavit or certificate is an exception to the rule that evidence must be given orally or *viva voce*.[97] In *S v Van der Sandt*,[98] a full bench of the high court held that admission of such evidence does not *per se* render the trial unfair in terms of the Bill of Rights (based on an infringement of the

93 Kirby and Downing 1999 *Obiter* 319.
94 Quoted in Goodwin and Meintjes-Van Der Walt 1997 *SALJ* 170.
95 *Criminal Procedure Act* 51 of 1977.
96 *Criminal Procedure Act* 51 of 1977.
97 *S v Van der Sandt* 1997 2 SACR 116 (W) 133D.
98 1997 2 SACR 116 (W) 132D.

accused's right to a fair trial in preventing him from cross-examination of evidence) – it all depends on the nature of the evidence.

Van Dijkhorst J[99] stated that the evidence generally admitted by a section 212(4) affidavit is of a formal, factual non-contentious nature and peripheral to the real issues before court. To this extent, the fact that cross-examination is excluded is not a limitation of the right to a fair trial.

It appears from the provisions of section 212(4)(a) that such an affidavit may be handed in, provided that the requirements for admissibility set out in the section have been met.

In order for an accused to be able to challenge or rebut the content of a section 212 affidavit, such an affidavit must contain sufficient details to establish the expertise of the deponent and the grounds on which his or her opinion is based.[100] This brings one to the question of what should be disclosed.

Meintjes-Van der Walt[101] is of the opinion that comprehensive, pretrial discovery of scientific evidence affords parties the means to challenge the expert evidence through cross-examination and/or to give an answer by way of their own experts. She recommends that a pretrial report should be disclosed and that it include the following information:

- a statement of all the material or other information or sources considered by the expert in arriving at an opinion
- the methodology used
- the quantitative results, together with any appropriate qualifications concerning the degree of certainty
- an explanation of any necessary assumptions or inferences that were needed to reach the conclusions

99 *S v Van der Sandt* 1997 2 SACR 116 (W)134.
100 *S v Van der Sandt* 1997 2 SACR 116 (W) 135G-I and 138A-J.
101 Meintjes-Van der Walt L "Pre-trial disclosure of expert evidence: Lessons from abroad" 2000a *SACJ* (13):158.

- a curriculum vitae indicating the expert examiner's qualifications and experience
- copies of any worksheets, photographs, graphs, printouts or other notes used to assist the expert examiner in reaching an opinion and recording the process of employing the methodology

In this regard, Traynor[102] notes that "the truth is most likely to emerge when each side seeks to take the other by reason rather than by surprise".

The nature of DNA evidence should be examined in view of the *dictum* of Van Dijkhorst J in the *Van der Sandt* case.[103] Marais[104] indicates that a DNA fingerprint, or profile, must satisfy the same individualising requirements as fingerprints, namely uniqueness, individuality, invariability, classifiability, universality and the ability to be reproduced.

However, in the view of Cassim,[105] "DNA fingerprinting" is a misnomer. According to Cassim, DNA profiling produces a pattern from the genetic material that has to be explained and interpreted and eventually accepted as the truth, whereas, with fingerprints, the various lines and swirls can easily be compared and matched.

Ligertwood[106] explains that, whereas the fingerprint expert gives an opinion on identity based on a direct, visual examination of various points on the fingerprints in question, DNA evidence is presented in a much more sophisticated manner.

Cassim[107] adds that in the case of DNA evidence it may be necessary for an expert witness to give their opinion on the results obtained from scientific analyses. He further submits that expert evidence will always be required in cases where DNA evidence is presented (although in reality, these experts testify only when required by the court).

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102 Quoted in Meintjes-Van der Walt 2000a *SACJ* 159.
103 *S v Van der Sandt* 1997 2 SACR 116 (W) 134.
104 Quoted in Olivier N "The role of DNA in the investigation of crime: A case for its use by South African investigators" 2002 *Acta Criminol* 15(2):84.
105 Cassim 1997 *Acta Criminol* 11.
106 Ligertwood A "Avoiding Bayes in DNA cases" 2003 *Australian Law Journal* 77(5):318.
107 Cassim 1997 *Acta Criminol* 14.

6.2 Recommendations

In the absence of evidence to the contrary, the contents of a section 212 affidavit will become conclusive proof of the fact established. It is submitted that a court should be cautious when admitting an uncontested section 212 affidavit regarding DNA evidence, because to do so will deny the defence an opportunity to challenge this evidence through cross-examination later in the case.

Section 35(3)(i) of the Constitution[108] provides that "every accused has the right to adduce and challenge evidence". The right to challenge evidence includes the right to cross-examine.[109] A prerequisite for cross-examination is that all evidence is produced in court and that witnesses testify *viva voce*.

7 DNA Criminal Intelligence Database

7.1 DNA Criminal Intelligence Database

The South African Police Service developed a DNA Criminal Intelligence Database that is administered by the Biology Unit of the Forensic Science Laboratory. The database comprises two components, namely a Reference Index and a Crime Index. The Reference Index stores the DNA profiles of convicted offenders and suspects in criminal cases. The Crime Index stores the DNA profiles recovered from crime scenes.[110]

Despite many benefits provided by DNA databases, some criticism has been directed at the establishment of such a database. Redmayne[111] believes that conventional investigative strategies will be replaced by a simple DNA database search when identifying an accused. Serious concerns regarding the furnishing of

108 *Constitution of the Republic of South Africa* 1996.
109 *Klink v Regional Magistrate* 1996 3 BCLR 402 (SE) 409g.
110 Quoted in De Gama J "Forensic and scientific developments in genomics and the impact on criminal and legal investigations: DNA testing" 2002 *De Jure* 35(2):303.
111 Redmayne 2002 *MLR* 20.

consent, the collection of samples, the chain of custody, and privacy have also been raised.[112]

According to Mooki,[113] the United States National Research Council has declared that DNA profiling and the creation of databanks pose a special risk of the invasion of privacy as far as medical and personal traits are concerned. Knowledge of such traits on the part of third parties (such as insurance companies and employers) may lead to discrimination against persons with particular traits.

Rifkin[114] predicts that "genetic privacy" will be the major constitutional issue of the next generation. The smallest item of DNA-containing material, a blood drop or bulb-containing hair shaft, carries with it all the genetic information that an insurance company or future employer may need to determine an individual's risk of contracting terminal or chronic diseases.[115] Lupton[116] suggests that with the completion of the Human Genome Project[117] and the massive amount of genetic information obtained during this process, many employees will become stigmatised as health risks and will struggle to find employment or obtain medical or other insurance.

In 2011, Joh[118] described the creation of an offence of "DNA theft" and listed some reasons for the need for such a crime: unregulated DNA collection and investigation by police (with specific reference to the collection of discarded DNA); unregulated collection of DNA-containing material in paternity and fidelity disputes, as well as for purposes of blackmailing; fans purchasing genetic information of their favourite celebrities, etcetera. The author further describes the practice of discreet or secret

112 Meintjes-Van der Walt 2008 *SACJ* 57.
113 Mooki 1997 *The South African Journal on Human Rights* 573.
114 Quoted in Lupton ML "Genetic engineering – the legal implications" 1996 *Tydskrif vir die Suid-Afrikaanse Reg* 1:63.
115 Lupton *Tydskrif vir die Suid-Afrikaanse Reg* 63.
116 *Tydskrif vir die Suid-Afrikaanse Reg* 64.
117 The Human Genome Project was a science project driven by the United States of America Department of Energy and the National Institutes of Health and completed in 2003. This project succeeded in identifying each and every gene in the human body.
118 *Boston University Law Review* 666-667.

DNA testing of people who would probably never have consented to such testing and the harm such testing may bring to the victims.[119]

The *DNA Identification Act* of 1998 of Manitoba, Canada, contains provisions regulating the collection, use and storage of DNA. Section 4, containing the preamble to the Act, reads as follows:

> 4. Principles – It is recognised and declared that
>
> (a) the protection of society and the administration of justice are well served by the early detection, arrest and conviction of offenders, which can be facilitated by the use of DNA profiles;
>
> (b) the DNA profiles, as well as samples of bodily substances from which the profiles are derived, may be used only for law enforcement purposes in accordance with this Act, and not for any unauthorised purpose; and
>
> (c) to protect the privacy of individuals with respect to personal information about themselves, safeguards must be placed on
>
> (i) the use and communication of, and access to, DNA profiles and other information contained in the national DNA databank, and
>
> (ii) the use of, and access to, bodily substances that are transmitted to the Commissioner for purposes of this Act.

The following outline is given by Clare[120] as to the legal position regarding the retention of DNA samples in England. The *Police and Criminal Evidence Act* of 1984 permits the retention of DNA samples after they have fulfilled the purposes for which they were taken. The retention is subject to the provision that they will not be used by any person for purposes other than the prevention or detection of crime or the investigation of an offence.[121]

The significance of this provision is that up until 2008 this provision was considered to be compatible with article 8 (the right to respect for family and private life) and article 14 (the prohibition of discrimination) of the European Convention on Human Rights.[122] The retention of DNA samples was deemed not to touch upon article 8 and

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119 Joh *Boston University Law Review* 668.

120 Clare A "Retention of DNA samples" 2002 *The Journal of Criminal Law* 66(4):296.

121 S 64(1)(A).

122 *R v Chief Constable of South Yorkshire* [2002] EWCA Civ 1275 – quoted in Clare A "Retention of fingerprints and DNA samples: Compatibility with the European Convention on Human Rights" 2003 *The Journal of Criminal Law* 67(1):23.

it was thought that, even if there was a breach of article 8, such a restriction would be proportionate to what is necessary for the prevention of crime.

In December 2008 the European Court of Human Rights (ECHR) issued a unanimous decision in *S and Marper v United Kingdom*[123] that the United Kingdom had infringed upon the right to a private life under Article 8 of the European Convention for the Protection of Human Rights and Fundamental Freedoms by retaining the fingerprints and DNA samples of a person "suspected but not convicted of offences".[124] The United Kingdom must now seek the most appropriate methods to implement this decision in new DNA retention frameworks.

In Australia, obtaining DNA samples from convicted offenders is a process governed by the provisions of the *Crimes Act* of 1958 (Victoria).[125] Three requirements must be met before a court will make an order for the taking of a DNA sample:

- The accused must be found guilty of a "forensic sample offence" listed in schedule 8 of the *Crimes Act*. The list is confined to serious criminal offences.
- The application must specify whether the sample sought is "intimate" or "nonintimate". A health professional must take an intimate sample, whereas a police officer can collect a nonintimate sample, like a mouth swab or a hair (not a pubic hair).
- The state must satisfy the court that the making of such an order is justified in the light of all of the circumstances of the case.

In addition, the *Crimes Act* authorises the retention, on a computerised database for purposes of crime detection and prevention, of the DNA profile derived from the analysis of DNA samples.[126]

In 1994, in the United States of America, the *DNA Identification Act* was promulgated to authorise the creation of the Combined DNA Index System (CODIS).[127] This is a

123 30562/04 [2008] ECHR 1581 (4 December 2008).
124 Swergold *Boston College International and Comparative Law Review* 179.
125 S 464ZF(2) and (3) – quoted in Ginsbourg S "Forensic samples under s 464ZF of the Crimes Act" 1998 *Law Institute Journal* 12(72):50-51.
126 *Crimes Act* 1958 (Vic) – quoted in Ginsbourg 1998 *Law Institute Journal* 50.

DNA profile database that enables police to identify suspects in offences where the perpetrator is unknown. It also allows for inter-laboratory and inter-state informational exchanges on profiles,[128] casting the net on possible DNA matches relatively wide.

In South Africa, new legislation in the form of the *Criminal Law (Forensic Procedures) Amendment Bill* has been drafted.[129] This Bill provides not only for the establishment, administration and maintenance of a national DNA database, but also describes the establishment of five different indexes, including a crime scene index,[130] a reference index, a convicted offender index, a volunteer index and a personnel, or elimination, index. Certain regulations pertaining to issues of privacy are also elucidated by the Bill.

Phase one of The *Criminal Law (Forensic Procedures) Amendment Bill* was enacted in 2010 and the *Criminal Law (Forensic Procedures) Amendment Act*[131] was signed into force in October 2010. All references to DNA databases and the establishment of DNA indexes as mentioned above were excluded from this Act, as it was decided by the Portfolio Committee on Police to dedicate a second Bill to the establishment, administration and use of a DNA database.[132]

One of the concerns presented by this committee in the establishment of a DNA database is the present competence of the police service in the implementation of such a database in South Africa and the constitutional challenges that will inevitably follow.[133] The National Assembly's Portfolio Committee on Police was scheduled to take the DNA Bill and the creation of a reported R8 billion DNA database under consideration later in 2010. However, the decision was made to research the best practice regarding DNA database management in selected foreign countries before

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127 Buckleton *et al Forensic DNA Evidence Interpretation* 447.
128 Buckleton *et al Forensic DNA Evidence Interpretation* 443.
129 B2–2009 GN 33607 in GG 31759 of 29 December 2008.
130 DNA obtained from biological samples found at a crime scene or on the victim of a crime.
131 *Criminal Law (Forensic Procedures) Amendment Act* 6 of 2010.
132 PMG 2010 *Criminal Law (Forensic Procedures) Amendment Bill: Secretariat of Police presentation*.
The second phase of the *Criminal Law (Forensic Procedures) Amendment Bill* specifically referring to the establishment of DNA databases will forthwith be referred to as the DNA Bill.
133 DefenceWeb 2009 *DNA database delayed?*

finalising the second phase of the DNA Bill.[134] It is hoped that finalisation of the DNA Bill will be achieved later in 2011.

8 Conclusion

Forensic science, including the use of DNA evidence, is making an important and ever-increasing contribution to the investigation of crime and the successful prosecution of offenders. However, the legal fraternity is confronted with complex scientific data when dealing with DNA evidence. This article, it is submitted, provides an adequate understanding of the interaction between DNA profiling and the law.

Forensic biological analysis is based on the Locard Principle of cross-transfer. The purpose of forensic analysis is to unequivocally establish a link between crime scene evidence and the perpetrator by means of comparative DNA analysis. The relevance of the Locard Principle for forensic testing is that an individual can either be included or excluded as a potential perpetrator as no one can be at a scene without leaving some trace of their presence behind.

Evidence collected at the crime scene and/or from the victim or perpetrator can provide important evidence in court. To realise the full discriminating potential of available biological evidence, meticulous procedures for evidence collection, documentation and preservation should be followed.

It is submitted that a multidisciplinary manual be compiled by an inter-disciplinary team of scientists, police officers and litigators. The purpose of such a manual will be to educate and guide the different role-players, especially members of the legal fraternity, from a legal and scientific point of view, regarding their duties and responsibilities with reference to forensic evidence.

Like police officials, medical professionals are in the privileged position of having evidence collection kits at their disposal. These kits are an indispensable part of criminal investigations. They reduce the likelihood of the contamination, mixing

134 Comments to: *DNA Laws are passed everywhere but here!* DNA Project 2010.

and/or mislabelling of samples during the collection of medico-forensic evidence. The thorough completion of the relevant forms ensures the proper documentation of evidence.

Improved testing technologies ensure more efficient and effective DNA evidence processing. The Forensic Science Laboratory makes use of the polymerase chain reaction amplification technique and short tandem repeat (STR) analysis. These methods have a distinct advantage over the previously used HLA polimarker test. They allow DNA typing results to be obtained using extremely small amounts of DNA, and STRs are excellent markers which can be used for identification purposes.

The Forensic Science Laboratory has subscribed to national and international quality control protocols and strictly adheres to these objective laboratory procedures. Positive and negative controls are used with every test and all results are generated in duplicate before being reported.

Statistical calculations are based on internationally accepted principles of population genetics which can be objectively confirmed by independent statisticians. The probability of two individuals sharing the same profile is determined by using the National DNA Statistics Database, which is suitably representative of the current population of South Africa.

The reliability of DNA evidence is disputable and is of fundamental importance when the identity of the accused is placed in dispute. There is a need for trial lawyers to become conversant with the current developments in forensic science to ensure that they have sufficient knowledge when adducing or challenging DNA evidence. Neutral, court-appointed experts, either giving evidence or acting as specialised assessors, should be introduced.

The South African Police Service is currently using a DNA Criminal Intelligence Database containing two indexes. The establishment of regulatory systems and additional indexes by the DNA Bill is anticipated and is yet to be finalised by government.

This article has emphasised the fact that the reliability of DNA evidence should not be questioned when all of the requirements for admissibility have been met. Furthermore, advances in technology and the establishment of a national DNA database promise to widen the use of DNA evidence as an investigative tool in South Africa.

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