DNA PROFILING:
THE MOST SIGNIFICANT BREAKTHROUGH IN
FORENSIC SCIENCE -
SINCE THE DEVELOPMENT OF FINGERPRINTING

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INTRODUCTION
Deoxyribonucleic acid (DNA) profiling is the most incontrovertible technique discovered in our modern era. It has already established its importance, not only in criminal investigation, but in questions of genealogy and paternity (Innes 2002:147). Before commencing to examine the significance of this scientific marvel, it is important to understand the concepts of DNA, criminalistics and individualisation.

DEFINITION OF KEY CONCEPTS
1. DNA
It is the human genetic blueprint of an individual called deoxyribonucleic acid or DNA (Gilbert 2004:313).

2. Criminalistics
Benett and Hess (2001:21) define criminalistics as the application of physical and biological sciences and technology to the scientific examination of physical evidence.

3. Individualisation
This is a process that takes place through comparison to another, used to establish that a disputed sample, when compared, is from the same origin (Marais 1992:19).

HISTORICAL BACKGROUND OF DNA
The father of the concept “DNA profiling”, commonly referred to as “Genetic Fingerprinting” is Alec Jeffreys of the University of Leicester in England. DNA is a genetic compound found in every cell of the human body. His discovery has enabled forensic scientists to individualise DNA traces found in biological and other bodily compounds. In 1987 a double homicide was solved when it was found that the suspect’s DNA matched semen at a murder scene. Moreover Dr Jeffreys’ profiling technique is even used in many non-criminal cases, such as paternity suits (Gilbert 2004:29). Since 1987 the DNA technique has become a forensic procedure throughout the world (Gilbert 2004:316).

THE GENETIC BLUEPRINT
Human cells consist of chromosomes made up of DNA which provides the genetic code to determine a person’s individual characteristics. No two individuals according to Gilbert (2004:313) share the same DNA sequence, except identical twins. DNA can reveal the sample donor’s gender, race, eye and hair colour (Bennett & Hess 2001:124). A human cell has 46 chromosomes which are unique and consist of the building blocks of A, G, C and T to form the DNA chain (Bennett & Hess 2001:124). Gilbert (2004: 314) explains that DNA consists of two strands of randomly stacked chemicals that intertwine to form a double helix resembling twisted rope and it is the particular appearance of the bands that provides the comparative image for positive identification. Since each individual is unique due to the genetic code, DNA can be used to create a genetic fingerprint to positively identify a person; this is done by using blood, hair, saliva, semen and cells from almost any part of the body (Bennett & Hess 2001:124).

SOURCES AND LOCATION OF DNA
DNA evidence can, according to Gilbert (2004:316), be located on the following items:

- Eyeglasses due to sweat or skin cells
- Tape or ligature due to skin cells, saliva or hair
- Dental floss, due to saliva, semen or skin cells
- On a can due to saliva
- On the rim of a glass due to saliva
- On a rim of a bottle due to saliva
- The end of a cigarette butt due to saliva
- On a washcloth due to saliva, semen, hair, skin cells or blood
- On a tissue due to saliva, semen, hair, skin cells or blood
- On a hat, mask or bandanna due to sweat, skin cells, hair or saliva
- On clothing or undergarments worn during or after an attack due to hair, semen, blood or sweat
- On blankets, sheets, pillows or other bed linen due to semen, sweat, hair or saliva
- On used condoms (inside or outside) due to semen or skin cells
- In saliva due to bite marks left
- Licked areas (such as envelopes) due to saliva
- In fingernail scrapings due to blood or skin cells.

When any of the above material is left at a scene of a crime there will be a possibility of finding DNA samples. Blood as a liquid or a dried stain is the most commonly tested substance, followed by semen which is pivotal to sexual crimes. It is important to note that DNA is not found in the seminal fluid but in the actual sperm cell (Gilbert 2004:316).

Regarding hair, DNA is found in the root material of hair, thus only hair which has been forcibly removed will contain sufficient cellular material for testing (Gilbert 2004:316). It must be kept in mind that DNA can be found in almost any cell of the human body, including bone regardless of age (Van Der Westhuizen 1996:43; Gilbert 2004:317). The age of the bones tested successfully for DNA has varied from 8 years to a 2400-year-old Egyptian mummy (Gilbert 2004:317).

Furthermore genetic material containing DNA can be obtained from items such as telephones, briefcases, car keys and gloves (Bennett & Hess 2001:124). In a most recent development according to Bennett and Hess (2001:124) Australian researchers have found enough DNA in fingerprints and palmprints to provide a genetic profile of a person.
AUTHENTICATING DNA

Claims have been made in America for specificity of DNA typing. In more than one case it has been disallowed when prosecuting counsel revealed insufficient understanding of the statistical mathematics involved. When a sample is taken from a crime scene and it matches that taken from the suspect it must be based on the frequency with which each identified fragment occurs within the population at large. If four fragments are identified, with the respective frequencies of 42, 32, 2 and 1 in 100, the probability that all four frequencies will appear in a single sample is 42x32x2x1=2686 in 100 million or approximately 1 in 37 000 (Innes 2002:155). The discoverer of DNA claimed that with this technique, the chance of a different person being matched by a set of four fragments is less than 1 part in 1,000,000,000,000,000,000,000,000,000,000,000,000 - a figure billions of times greater than the present world population (Innes 2002:158).

DNA - NOT ONLY FOR HUMANS

It is not only human DNA that can play a vital role in proving guilt or the innocence of a person: A murder occurred on Princess Island, Canada, and during the investigation a leather jacket belonging to the suspect was found. The jacket, apart from containing the victim’s blood, was also covered on the inside by a number of white cat hairs. The blood found on the jacket matched the DNA of the victim. The help of a geneticist, Dr O’Brein who studied cats was obtained. He extracted DNA from the root of the hair and found blood from the suspect’s cat, Snowy. It was a perfect match. The expert also took blood samples from 20 other cats and extracted DNA. The results showed a distinct genetic diversity amongst all the cats. Scientifically Dr O’Brein proved that the chance of a profile match was 1:700 000 000.

In South Africa DNA technology was applied in a stock theft case to settle a legal dispute concerning the origin of some ostriches. The test was successful (Van Der Westhuizen 1996:47). The value of DNA in criminal cases is not always considered reliable, not because of the fallibility of DNA but due to the methods used to collect and store the evidential material, as was evident in the O J Simpson case. The DNA was rendered worthless based on the methods used to collect and store the material on which the DNA analyses were to be performed (Bennet & Hess 2001:153). Any material not speedily sent for DNA analysis, should be stored in a freezer, refrigerator or at room temperature (Gilbert 2004:317).

INDIVIDUALISATION BY USING DNA

The discovery of DNA has made it possible to exonerate the innocent and solve intricate and cold cases or forgotten crimes (Gilbert 2004:317).

1. Solving crime

The application of DNA analyses has ensured that many serious crimes do not remain unsolved.

The following serve as examples:

1.1 The Dudley Friar Case

Forensic work uncovered the identity of a man who raped and strangled three women in New York within 3 weeks, but DNA clinched the case. DNA typing indicated that the same suspect was likely responsible for two rapes but not the third; analysis of the third case where semen was found for some inexplicable reason was unsuccessful. Rubbish taken from the scene of the third murder contained a cramped paper handkerchief stained with nasal mucus. Under a microscope a large clump of white blood cells was found, an ideal source for DNA typing. On analysis the DNA matched the semen from the first two murders (Innes 2002:151).

1.2 The Carla File

During 1998 a 12-year-old Bavarian schoolgirl was raped and murdered in Germany. Her body was dumped in a pond. Floating in the pond a number of cigarette ends were found. DNA in the saliva on the cigarette ends was found to match semen samples taken from the victim’s body and positively linked to the suspect (Innes 2002:153).

2. Exonerating the innocent

FDA reports show, that 75% of DNA samples examined, can either conclusively link a suspect to a crime or exclude the suspect (Gilbert 2004:317). The US Justice Department reports contain examples of 28 cases (in 1 year) of men convicted of rape who were later freed from prison based on DNA testing that proved them blameless (Gilbert 2004:317). Prior to the application of DNA, many innocent people confessed to crimes and were sent to jail or even executed.

Two pertinent cases serve as example:

2.1 The Roger O’Dell Case

Although there were serious reservations about Roger O’Dell committing a murder, rape and sodomy in 1985, he was sentenced to death. The evidence rested on blood found and a fellow in-mate’s testimony. Although numerous petitions were sent asking for DNA testing to be done on the evidence found, this was ignored and O’Dell was executed in July of 1997 (Friedland:1997).

2.2 The Earl Washington Case

In 1984, Washington, then in his early 20s, was convicted and sentenced to death for the murder of 19-year-old Rebecca Williams. His conviction was largely based on confessions to the police. After all appeals had failed, Washington’s lawyers turned to Governor Wilder. Wilder wanted DNA tests done before making a decision. The new test excluded Washington’s DNA. Prosecutors would not budgie and floated a new theory that the DNA belonged to an accomplice of Washington’s. The Governor ordered one more test, the test of a blanket for DNA. The results were kept secret. On the last day of office the Governor made a call to Washington’s lawyers. They had 2 hours to accept the Governor’s clemency offer, life imprisonment rather than execution. An organisation called Frontline managed to obtain a copy of the DNA results. The tests eliminated Washington as a suspect. Washington was still not released. In 2000 the next Governor ordered more sophisticated DNA testing. In February 2001 Washington was finally released and pardoned after the new tests found no trace of his DNA on evidence from the crime scene. He had served nearly 18 years in prison (Friedland:1997).

The value of DNA in criminal cases is not always considered reliable, not because of the fallibility of DNA, but due to the methods used to collect and store the evidential material. Evidence must be correctly collected and stored.

3. The Cold Case Concept

The “cold case” concept emerged in the mid 1990s as a direct result of using and processing DNA. Investigators and other roleplayers realised that many cases could be solved by applying modern technology, for example testing DNA evidence from old, unsolved crimes. Evidence of 40 or 50 years old can still show traces of DNA (Gilbert 2004:555). Modern DNA testing is so advanced that comparison is made of at least 10 genes compared to a single gene in the past. In June 1999, the FBI, by using its database NDIS made its first “cold hit”, linking three sexual assault cases in Jacksonville, Florida, with six cases in Washington DC (Bennett & Hess 2001:124).

4. DNA FOILS THE SO-CALLED PERFECT CRIME

The use of DNA technology has been applied to foil the so-called perfect crime. An accused lured his former wife into a shopping centre and then into a crematorium where he was employed as an usher. He murdered her and activated the furnace to cremate her body. It would take approximately 2½ hours at a temperature of 1500 °F. One of the burners in the furnace malfunctioned and the cremation was not complete. Later the remains recovered, consisting of part of a femur bone and tissue from the pelvis, were tested for DNA and compared to the blood samples of the victim called Frontline. A match was found and it was possible to individualise the victim positively.

Without the DNA matches, the evidence would have been purely circumstantial and too inconclusive to prosecute the offender (Van Der Westhuizen 1998:48).
DNA DATABASES

Law enforcement agencies worldwide have come to realise the true value of DNA analyses, keeping in mind that crime is a worldwide phenomenon. Thus many countries and agencies have created their own DNA databases.

1. The South African DNA Database

South Africa has facilities for DNA testing and a DNA Criminal Intelligence Database (DCID). During 2004-2005, 50 969 DNA exhibits were analysed and 44 467 were finalised. In 256 instances, suspects were linked to another case not related to the one of the initial arrest by using the DCID. A further 407 cases were linked by means of DNA examination without any suspects to make comparisons to.

2. The Chinese DNA Database

In Beijing preparation is under way to create a DNA data bank to help police track down serious criminals such as rapists and murderers. Part of the initiative will be to gather DNA samples from convicts prior to their release.

3. The US Department of Defence Database

The Department of Defence has established a military/ naval DNA identification system to help identify soldiers whether dead or alive (Bennett & Hess 2001:124).

4. The FBI Database in America

The FBI has a database of almost 600 000 offenders. The database is called the National DNA Index System (NDIS). This database makes it possible to allow states in America to exchange DNA profiles and perform comparisons (Bennett & Hess 2001:124).

5. The combined DNA index system (CODIS) in America

This is the "mother" of all DNA databases. It is a computer database of DNA "profiles" of offenders convicted of serious crimes such as rape, sexual assault and murder. In 2001 CODIS contained approximately 250 000 profiles (Bennett & Hess 2001:124).

6. The British DNA Database

The British has a DNA database which was sanctioned by the introduction of legislation in 1996, namely the Criminal Justice and Public Order Bill which sanctions the utilisation of DNA in all criminal cases (Van Der Westhuizen 1996:48).

FUTURE APPLICATION OF DNA

The future of the use of DNA forensic technology is truly mind-boggling. This will involve a forensic DNA Chip, the electrophoresis system, mitochondrial DNA and a genetic criminal law system.

1. The Forensic DNA Chip

This kind of technology will enable police on the street to use DNA at the scene of a crime. The chip will extract DNA from biological evidence in a sealed, tamper-proof container. It will identify the genetic codes and relay the markers to a computer screen in the vehicle of the investigator. A national data base linked to the computer will

search for possible identification of a culprit on file (Bennett & Hess 2002:125).

2. The Electrophoresis System

The electrophoresis system is a portable unit that can be run outside the laboratory to test for the presence of DNA, and it produces results within 35 minutes. The process has a distinct advantage since it reduces the chance for error due to contamination or delays (Bennett & Hess 2002:125).

3. Mitochondrial DNA (mtDNA)

Recent discoveries have expanded the traditional testing of DNA which has led to the discovery of Mitochondrial DNA (mtDNA). This is more accurate in profiling. It is possible for mtDNA to be extracted from smaller, older crime scene objects. Where latent fingerprints found at a crime scene may lack ridges to make an identification, criminals can now obtain mtDNA from latent fingerprints (Gilbert 2004:568-569).

4. The Genetiised Criminal Law System

Prof Steven Friedland, a professor of Law at Southeastern University Law Centre in Florida (1997: 303-366) maintains that DNA fingerprinting can be of value to focus on the genetic disorders of offenders. According to him there is a genetic link between crime and conditions such as alcoholism and antisocial behaviour. Dutch researchers have supported this claim in the discovery of a genetic link to violent behaviour. Genetic information might serve to predict the future threat posed by an accused or serve as an exculpatory factor in making decisions for sentencing such as gene therapy to rehabilitate a convicted criminal.

Prof Friedland postulates that in future a person engaged in an affair or a motorist who exceeds the speed limit, could be asked for a driver's licence and a genetic propensity card to run a check. Upon discovering the genetic propensity of an accused, this information could be circulated through computer files nationwide to see if a match could be found. The value of this kind of system would be that individuals who proclaimed their innocence and those who admitted their guilt could be tested almost immediately to avoid a miscarriage of justice.

CONCLUSION

Over the last decade the research, use and application of DNA have developed beyond imagination. Law enforcement agencies will have to adapt and create new strategies of investigation based on the genetic propensities of suspects.

One may very well ask: are they ready for the challenge? Only time will tell.

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