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"DNA Profiling"

by

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DNA PROFILING: A FORENSIC CHALLENGE

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Possibly no other area of forensic science is presently subject to such significant development and rapid change than the area of molecular biology known as DNA profiling.

Biological criteria have long been used as a means of characterising individuals. For example, evidence of various types of protein/enzyme analysis (eg ABO blood groupings or the more precise - because more detailed - HLA blood groupings) has been used for many years, particularly in criminal cases (although by no means restricted to such cases).

In addition to criminal cases, biological testing for individuality - and more recently specifically DNA profiling - has been increasingly used to determine paternity in family law and immigration cases and even in civil cases involving disputes about Wills. Where the parentage of a child (ie it is not limited to paternity) is in issue in proceedings under the *Family Law Act* 1975 (Com) the Court may make an order requiring a "parentage testing procedure" to be carried out. [1] The specific procedures which may be ordered are set out in reg. 21A and 21B *Family Law Regulations*. They are blood grouping, HLA tissue typing, [2] serum markers and DNA typing.

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* Barrister, Wickham Chambers, Perth. A much briefer and unpublished version of parts of this paper was presented at a Western Australian Criminal Law Association Seminar on DNA evidence in Perth in October 1995.

1 66W(1) *Family Law Act* 1975 (Com)

2 Human leucocyte antigen tissue typing

Other forensic or investigative applications of DNA testing have included coronial enquiries and the identification of victims of crime, accident or natural disaster. [3]

The two main weaknesses of evidence of biological testing for identification have been the problems of degradation or contamination of samples and the statistical interpretation of the results. Its main practical utility has been exclusionary. Thus, a person may readily be excluded as the origin of the sample but if not excluded, he or she then must be regarded merely as one of a (relatively large or smaller) population group with that same characteristic. Whether or not the person is proved to be the source of the sample will depend upon other evidence. (So if, for example, the sample could only have come from one of two people and the DNA results exclude one, then on the evidence it must have come from the other.)

It is important to understand from the outset that contrary to some exaggerated claims about DNA profiling, it is still fundamentally subject to those same weaknesses. Whilst the problem of sample degradation may not always feature so largely however, it can still be of critical importance depending on the type of DNA tests used; possible contamination of forensic samples is always a danger and the problem of what conclusions may properly be drawn on the basis of population statistics is likely to remain a significant issue for some time. It is still true to say that the primary utility of this form of biological testing remains in its capacity to exclude, rather than include.

DNA evidence which does not exclude a person as being the source of a particular sample is obviously by no means proof of itself that he or she is that source; and that is so no matter what the statistical probabilities or possibilities may be. A finding that the person was in fact the source will depend upon a combination of facts (established by evidence) of which the relevant DNA characteristic and the frequency with which it occurs in the general population, are only part.

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3 For example, DNA tests had ultimately to be used to identify victims of the Panam crash at Locherbie and to both identify and collect together body parts of those killed at the Waco seige in the United States.

As long ago as 1944 an American researcher, Oswald Avery, defined the role of DNA in transferring hereditary characteristics. Its unique spiral structure was described in 1953. By 1978 several laboratories were focussing on DNA research and genetic variation. From a forensic perspective the leading work was done by Professor R White of the University of Utah and Dr A Jeffreys of Leicester University, who were respectively seeking better and more detailed scientific genealogical family information and a better means of examination of the genetics of family-transmitted diseases.

In 1984 Dr Jeffreys devised a new means of visually identifying a particular form of DNA variation. That ability, combined with the distinctive variation in DNA patterns in certain regions between individuals except in cases of identical twins, provided the scientific impetus for the forensic use of this new technique.

DNA profiling is a procedure for examining the genetic makeup of an individual ("Genotype"). Atchison and Georgalis describe it this way[4] :

> "Each human being is composed of millions of cells with the genetic information of the cell contained within the nucleus. Each cell of the body contains identical DNA except for reproductive cells (egg and sperm) each of which contain half the complement of genetic information. Certain specialized cells in the blood stream (red blood cells) do not contain nuclear DNA, and, thus, when examining DNA from blood, the DNA is derived from white blood cells (leucocytes). Cells from different body structures (eyes, ears, hair, etc) have the same DNA, but due to the switching on/off of various genes by a process not well understood, these cells generate different products resulting in the creation of different tissues.
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> The DNA in the nucleus is not free in solution like salt in the ocean but forms specific structures called CHROMOSOMES. In the normal human cell there are forty-six chromosomes: 22 pairs of chromosomes called autosomes and two chromosomes which determine the gender of an individual (an X and Y in a male and two X chromosomes in a female). In the formation of the egg or sperm, one chromosome of each pair appears in the reproductive (germ line) cell, ie 22 autosomes (one of each pair) and one of the X/Y, X/X combination.

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4 Atchison & Georgalis, "*DNA Profiling: A Review of the Techniques and Interpretation of DNA Testing*", Leo Cussen Institute, 1990, p.3.

A specific location on a chromosome is termed a "locus" which has been determined by genetic studies. Within a particular locus there may be slight differences in the DNA - these are known as ALLELES. In DNA profiling terminology a locus refers to the location on a chromosome detected by a probe and the term "allele" refers to the different size DNA fragments detected with one probe (BANDS).

The simple determination of which alleles are found in an individual's DNA is of no use for identification unless the frequency at which these alleles occur in the general population is known. This frequency is determined by examining samples of the population and the frequencies of individual alleles are multiplied together to obtain the frequency of the total DNA profile. This is similar to current technology where population frequencies for ABO group haptoglobin type, etc, are multiplied together to obtain a measure of how common the combination is in the population. This requires that the individual loci are genetically and statistically independent."

It is beyond the scope of my brief to discuss in any detail the structure of DNA, the methods of isolating and testing it or the several DNA profiling techniques.[5]

The most forensically significant differences between DNA profiling and previous biological tests are that -

- DNA profiling is more discriminating in that there is a vast number of points of individuality;
- DNA tests can be undertaken not only with blood samples but with any biological material containing DNA, such as body tissue, hair etc;
- accurate DNA results can now be obtained by certain methods from minute samples;
- testing can be done on samples many years old;

5 The biological and genetic theory of DNA is explained by Dr Paul Raffey in "The Living Molecule Called DNA: A Review of its History, Structure and Function" Journal of Law & Medicine, Vol 2, Nov. 1994, p.98

- given an appropriate population database the statistical chances of a match can be infinitesimal (which from an evidentiary point of view would be expressed as the probability of the subject's DNA matching the sample by random chance is only one in many millions!).

But great caution must be exercised about such assertions of statistical probability.

For example, researchers studying a database of 35 Mayan Indians in Mexico found a match with another an Amazonian tribe some 2000 miles away. The chance of a random match had been said to be 1:95 million - yet as that result fortuitously showed, it was in fact only 1:35, because a match was found.[6]

So too, the Court of Appeal in England has warned against transmuting, on the basis of serological evidence, a mathematical probability of paternity into a forensic certainty. [7]

Before turning to some of the legal implications of the different techniques, it is as well to remind ourselves that DNA evidence is subject to the same evidentiary and legal constraints as any other expert evidence. Thus, attention should be given to whether or not the particular technique and opinion is within a recognized or organized branch of science, whether the particular witness is appropriately qualified by study or practical experience, whether the samples were properly collected and preserved, whether they have or may have been contaminated, whether there is capacity for independent validation of the tests, what laboratory methods were employed, the potential for human or other error in any of those respects, and, of course, whether the necessary factual foundation has been laid for the expression of the expert opinion, to mention but a few.[8]

There is a danger that the mystique of esoteric expert scientific evidence may by its own force in the end be uncritically accepted by counsel and the court. This is especially so in cases of circumstantial evidence, where

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6 This example was discussed in the 'Equinox' programme "Incredible Evidence" Channel 4, (UK) Dec.1994.

7 ***In re JS (A Minor)*** (1981) Fam. 22,29

8 See The Hon Justice Von Doussa "*"Difficulties of Assessing Expert Evidence"* (1987) 61 ALJ 615 and on expert evidence generally and DNA testing in particular, "Expert Evidence" by Freckleton & Selby, Law book Company Practical Law Library, Vol 1, esp.Part 1B.

particular caution is called for. There is a heavy responsibility on a judge in such cases to ensure that the limitations of such evidence are properly appreciated - and in a jury trial, to ensure that his or her directions to the jury adequately address them.

The case of ***Carroll*** [9] is an example. There the evidence was entirely circumstantial. Carroll was in fact convicted of murdering a child. The identity of the killer was the major issue in the trial. The Crown case turned on 3 categories of evidence, they being evidence of similar acts, evidence that he was not present at a RAAF recruit course interstate at the relevant time and, pertinently to the present subject, forensic odontology experts testifying that bruise marks on the deceased child's thighs were caused by him.

The Queensland Court of Criminal Appeal upheld Carroll's appeal against conviction, concluding that the so-called "similar fact" evidence was not sufficiently probative to have been admitted, that even if the jury were satisfied he had not been present on the recruit course there was no direct evidence that he was in his home town (the scene of the crime) at the time when, if he had been some evidence of that could be expected, and the evidence of 3 odontologists called by the Crown, described as "the linchpin" of the prosecution case,[10] was subject to significant discrepancies. The experts acknowledged there was a body of expert opinion within their field which held that valid identifications cannot be made by reference only to bruise marks and that they should be relied upon only for the purpose of excluding suspects and not for positive identification.[11] There were significant unexplained discrepancies in the evidence.

The reliability and cogency of odontological evidence was again called into question in the Northern Territory in ***Lewis*** [12] two years later, in which a conviction for assault with intent to have carnal knowledge was set aside on appeal. Maurice J pointed out that it is not enough to rely upon the credentials and experience of an expert witness, however eminent: in determining the admissibility of opinion evidence a court

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9 *Carroll* (1985) 19 A Crim R 410.
10 Ibid, per Shepherdson J at 424 and 434.
11 Ibid, Kneipp J at 414.
12 *Lewis* (1987) 29 A Crim R 267.

must consider the body of knowledge from which inferences are drawn and decide whether it is sufficiently established to have gained general acceptance within the scientific community from which it originated.

Maurice J said this [13] -

> "Forensic evidence, especially if it goes to a vital issue implicating an accused person in the commission of an offence, may often have a prejudicial effect on the minds of a jury which far outweighs its probative value. The jury, being people without scientific training, may often be impressed by an expert's qualifications, appointments and experience and the confident manner in which he expresses his opinions. And yet it ought not be left to such matters alone to provide a foundation for the jury making an assessment of the probative value of forensic evidence, particularly where there are conflicts in expert testimony, or where it is acknowledged that other experts of more or less equal distinction are unlikely to agree.
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> For my part I think that whenever the Crown wishes to reply upon forensic evidence the prosecutor has a clear duty, not just to his client, the Crown, but to the trial judge and the jury to acquaint them, in ordinary language, through the evidence he leads, with those aspects of the expert's discipline and methods necessary to put them in a position to make some sort of evaluation of the opinions he expresses. Where the evidence is of a comparatively novel kind, the duty resting on the Crown is even higher: it should demonstrate its scientific reliability. It is not an answer to considerations that dictate these things be done to say the defence may draw it out in cross-examination; that is an abdication of the Crown's primary function in a criminal prosecution."

There was too, in that case, reference to the element of subjectivity in comparison,[14] which is a feature of DNA profiling techniques.

In ***Griffith*** [14A] the Queensland Court of Criminal Appeal unanimously held inadmissible opinion evidence from police witnesses identifying the accused as the person photographed by a security camera and wearing a stocking mask. The Court suggested that although it

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13 ibid, p.271.
14 ibid, Maurice J at 273
14A *Griffith* (1995) 79 A Crim R 125.

> "...would not entirely rule out the possibility of a person becoming an expert by experience, and perhaps experiment, in the distortions of features produced by the placing of a stocking or similar constricting material over the head..." [14B]

in that case no effort had been made to adduce evidence that the police officers were qualified experts in that subject. Their evidence was accordingly inadmissible.

The first reported Australian case on DNA profiling demonstrated major failings in each of the fundamental constituents of such evidence, namely practical test results and statistical comparison.

In the New South Wales case of ***Tran***, [15] McInerney J ruled the prosecution's DNA evidence inadmissible.

The Crown had sought to lead it to establish a connection between the Vietnamese accused and the victim of a rape and murder. A number of vaginal swabs and one bloodstain from the deceased together with four bloodstains from the accused were sent to *Cellmark Diagnostics* in the UK. These were subjected to RFLP testing. Four tests were done but only one x-ray film, or autorad, was relied upon. The others were inconclusive. In the autorad relied upon, two identifying bands were very faint and were the subject of dispute between the expert witnesses. It was acknowledged that there was no way the finding could be duplicated or corroborated by further testing.

McInerney J pointed out that the determination of the very existence of a band in the circumstances was a matter of expert subjective determination -

> "...and that a lay person, unpractised in such technology, would be unable to make an independent accurate judgment in these circumstances by viewing the autorad that undoubtedly would be in evidence before the jury."[16]

14B Ibid, p.128
15 ***Tran*** (1990) 50 A.Crim.R.233
16 ibid, p.237

Expert witnesses called by the defence disagreed that there were two faint bands which matched those on the accused's sample. They suggested "leakage" from one track to another in the autorad and that the bands were too faint to make a diagnosis anyway. There was a possibility of contamination by DNA from bacteria - which could have been excluded by a simple test but that had not been done. It was suggested there was a problem with interpretation of the results in that the prosecution experts were preconditioned by looking for similarities rather than differences. There was no allowance for sampling error in the statistical database upon the basis of which the experts had opined the chance of an unrelated individual matching the bands produced was 1:152. The database, however, was made up of 300 Caucasians, 300 Afro-Caribbeans and 300 Asians (mainly from Pakistan and Bangladesh). It did not include any Vietnamese.

Ultimately McInerney J concluded [17] that to put the evidence before the jury would produce a misleading and confusing impression and that -

> "In any event, even if I were of the opinion that it would be open to the jury to conclude that these were matching bands and they matched the bands of the accused, thereby linking him against a one in 152 coincidental chance, if one accepts that figure, or alternatively one in 87 the state of the evidence is in an unsatisfactory state because of the fact that there is no database for Vietnamese."[18]

Even if he were wrong in concluding that the jury would not be capable of determining the threshold question, he would still have excluded the evidence because its prejudicial influence would have outweighed any probative weight it may have had.

DNA evidence sought to be led by the Crown encountered other similar difficulties in Victoria the following year, although in that case ***Tran*** was apparently not referred to.

In ***Lucas***, [19] Hampel J excluded DNA profiling evidence principally because the jury had no basis upon which they could independently evaluate it. Significantly, the case highlighted the distinction between the

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17 ibid, p.242
18 ibid, at p.242
19 *Lucas* (1991) 55A.Crim.R.361

two relevant areas of expert knowledge, his Honour accepting the expertise of the molecular biologists as to the tests conducted by them, but not accepting either the prosecution or defence biologists as expert statisticians or population geneticists. That being so he could not have regard to their opinions in the area of the calculation of probabilities in a population. It was this which ultimately resulted in the exclusion of the evidence because there was no way the jury could properly weigh the value of the DNA test results if there was no evidence before them as to the frequency of a match in the general population.[20]

Unlike the biological testing procedure in ***Tran***, that used in ***Lucas*** was one developed by a United States company, *Lifecodes Corporation*. As with *Cellmark*, its DNA testing technology is provided under licence and had been used on that basis by the Victorian State Forensic Science Laboratory, which also relied upon population data from *Lifecodes* to determine how common a given profile is in the general population. This was apparently based on samples of the USA Caucasian, African and Hispanic populations.

Commercial confidentiality was a problem. The testing procedure, being under patent, was provided only under conditions of strict secrecy. Laboratory manuals were provided under subpoena only on undertakings to maintain confidentiality. It was therefore not possible to examine the sampling or testing procedures other than by comparison with *Lifecodes'* own manuals.

In his judgment, Hampel J explained in typically concise terms the process of RFLP analysis and the various difficulties manifested with it at different stages on the evidence before him. His Honour then evaluated the evidence by a four-stage analysis -

- obtaining the samples;
- processing the samples to obtain autorads;
- matching profiles from the known and unknown autorads; and

20 ibid, p370

- calculating the probability of a match with the known sample which would be found with a member of the population chosen at random.

I shall not canvass them here; suffice to say his Honour's analysis repays close study.

One of the more interesting by-products of the current increasingly critical examination of DNA evidence is the (belated) recognition that the relationship between other expert evidence and population statistics is founded on similar principles and that some areas of forensic opinion have been virtually uncritically accepted by the law when perhaps they ought not to have been. Fingerprint and blood-type analysis are two examples.[21]

The statistical database to justify the assumptions on which fingerprint evidence is based is problematical; and more importantly, the fact that fingerprint "identification" is based entirely on human comparison has yet to be adequately tested.

But to return to more particular issues of expert evidence, in ***Jeffrey*** [22] the Tasmanian Court of Criminal Appeal dismissed an appeal by an appellant against his conviction for murdering his father. The evidence was circumstantial. Part of it was the presence of blood stains on his clothing. A forensic scientist called by the Crown testified that the blood was consistent with the deceased and that it was shared by only a very small percentage of the population (in one study as little as 2.4%). In giving this evidence the expert relied upon the published articles of another expert who was not called. On appeal, the Court held that the evidence was admissible. The rule against hearsay does not prevent the use of statistical or scientific data proved to come from a reliable source. Thus, the factual material of that nature relied upon by the expert was shown to be -

> "...part of the corpus of his field of science." [23]

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21 There was also an extremely useful critique of evidence of identification based on fingerprint comparison in Equinox" Incredible Evidence" Channel 4 (UK) Dec. 1994.

22 ***Jeffrey*** (1991) 60 A.Crim.R.384

23 ibid, p.390, per Cox J

In the Supreme Court of Queensland in July 1992 the Crown again sought to rely upon the evidence of Dr Roberts (who had been the leading prosecution witness in ***Lucas***) to establish a DNA link between the accused and the deceased. The defence sought to have Dr Roberts' evidence excluded on the same basis it had been in ***Lucas***, ie principally because he was not a population geneticist and so could not give expert evidence as to the statistical chances of the laboratory results being a coincidental match. That case was ***Sopher***. [24] Unlike ***Lucas*** , however, the evidence was admitted and Sopher was convicted, Byrne J holding that although the witness was not a statistician he had sufficient knowledge of the concepts of population genetics requisite to the predictions of the frequencies of DNA profiles occurring in a population to give "useful evidence". Furthermore, Dr Roberts did not need greater knowledge of mathematics generally or statistics in particular to calculate the material frequencies. Such statistical knowledge as he had acquired and applied in practice was "adequate" for the purpose.[25]

Essential concepts considered in that case included the "multiplication" or "product rule", "linkage disequilibrium" and "Hardy-Weinberg equilibrium".

As Byrne J explained, [26] the essential reference is a DNA database of the relevant population - and it is essential that database be representative of the relevant population (my emphasis). The probability to be calculated is that of a match between the accused and a person chosen at random from that population. To do that it is necessary to know how frequently the specific allelle found in the sample occurs in that population. When more than one allelle is identified the frequency with which each occurs is multiplied by the frequency of the others. That is known as the "product" or "multiplication rule".

That, however, depends on a number of conditions.

First, the allelles at the given locus must be independent. If they ordinarily tend to occur in conjunction with one another, then obviously

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24 ***Sopher*** (1993) 74 A.Crim.R.21
25 ibid, per Byrne J at 24
26 ibid, p.23

the product rule cannot be used. That phenomenon is called the "Wahlund Effect". (Where allelles at different loci are not independent the phenomenon is called "linkage disequilibrium").

Likewise, the population in which they occur must be shown to be a randomly-mating population. That is what is described as one which is in "Hardy-Weinberg equilibrium". But a word of caution. There is considerable controversy amongst population geneticists that population substructures of groups (eg ethnic communities) within a larger population with specific allelle frequencies, may affect the validity of the product rule.

In ***Sopher***, Dr Roberts' evidence was that:

(a) the Victorian population does not differ substantially from Hardy-Weinberg equilibrium;

(b) that database may be relied upon in the present case, there being no reason to suppose that Queensland circumstances are materially different;

(c) there were no significant relevant differences between subgroups in the Australian population;

(d) even if there were, there was no significant departure from Hardy-Weinberg equilibrium;

(e) linkage disequilibrium was of no concern here;

(f) the detected bands were independent so it was appropriate to apply the product rule;

(g) there was "a 97% level of confidence that the true frequency (sic:ratio) (was) not greater than 1:4,700".

The defence expert expressed different views (including that the prospect of a chance match was 1:600). However Byrne J considered these were

matters to be assessed by the jury. On balance, His Honour concluded [27] that there was no serious risk the jury would be overwhelmed or their critical faculties suppressed to the point at which they may not discharge their responsibility of assessing the weight of the DNA profiling evidence.

Following Sopher's conviction there was an appeal to the Queensland Court of Criminal Appeal on the admissibility of the DNA evidence and other grounds. The appeal was dismissed. Derrington J (with whom the Chief Justice agreed on this), responded to the defence contention that the implications of the evidence were too inconclusive to be useful and its prejudicial effect outweighed any probative value it had, with the observation that even at its weakest, on the acceptance of the defence evidence, it was still a powerful piece of circumstantial evidence in association with other supporting evidence and that:

> "...it was stronger than the evidence often accepted without hesitation in respect of the statistical chances of identity of blood groupings." [28]

As to the argument that the databank used by the Crown was defective as insufficiently representative, Derrington J disposed of that with the observation that:

> "...the nature and degree of any suggested defect and its implications are of little or no consequence here. While in the end it was for the jury to use it as they wished, this feature was not so serious, alone or in conjunction with any other factor, as to require the exclusion of the evidence." [29]

The circumstantial relevance of expert evidence that certain objective features were consistent with an accused was illustrated again in ***Rose***.[30] He was convicted in the District Court of South Australia of armed robbery, causing grievous bodily harm with intent, wounding with intent to do grievous bodily harm and attempting to pervert the course of justice. The case against him depended entirely on circumstantial evidence. Relevantly to the present discussion, the trial Judge admitted evidence of two podiatrists as expert evidence connecting an examination

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27 ibid, at p.26

28 ***Soper*** (sic) ***v The Queen*** (unreported) CCA, Qld. CA No. 245 of 1992, 11/3/93, per Derrington J, p.2

29 ibid, p. 2-3

30 ***Rose*** (1993) 69.A.Crim.R.1

of the accused's feet with shoes found discarded (with other objects including a jemmy, a baseball bat, two balaclavas and gloves) in a drain near the crime scene. On appeal it was held that expert evidence was admissible. It was led to show the shoes could have been worn by the accused and it otherwise met the requirements for the admission of expert evidence. As Bollen J put it: [31]

> "If these shoes would not fit his feet at all then they would not sheet home guilt or play any part in connecting him to the crimes. If he could wear the shoes then they and the fact that he could wear them was capable of being some use in the reaching of a verdict."

In that case, it was not a matter of comparison or identification per se, (as opposed to eg ***Carroll*** and ***Lewis***) but rather evidence of characteristics and points of comparison to be seen on both the foot and the shoes from which circumstantial evidence an inference could ultimately be sought to be drawn (in conjunction with other circumstantial evidence) that there was a connection with the accused. [32]

DNA profiling evidence is in the same category: of itself it cannot constitute evidence of identification but merely non-exclusion, and any expert who expresses an opinion in that form should be taken to task upon it. Thus an assertion that there is a (certain) statistical probability that X is the source of the sample simply cannot be correct: at best, it could be said only that there is that statistical probability that the sample from X and one taken at random from the relevant population would match.

The relationship between the results of biological parentage tests conducted under the *Family Law Regulations* and the inferences which may be drawn from such results, and indeed from a refusal to undergo such tests at all, was considered in ***Re C (No 2).*** [33]

In that case parentage tests had been ordered by consent. Initially two reports were prepared. The first was based on analysis of red cell antigen blood grouping, red cell enzyme blood grouping and serum markers. The second was based on DNA typing tests. Fogarty J held the second

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31 ibid, p.7
32 ibid, per Bollen J at 8
33 ***Re C (No 2)*** (1992) FLC, 92-284, Fogarty J

report inadmissible for failure to comply with the time limits stipulated in the *Family Law Regulations* and ordered further tests be conducted. [34] The Respondent refused to take part.

Fogarty J held that the combination of evidence as to intercourse at or about the relevant time, the results of the first (admitted) test and the Respondent's refusal to take the second one, was sufficient to lead to the conclusion on the balance of probabilities that the Respondent was the father of the child.

His Honour observed [35] that the findings and conclusions of the antigen blood group etc testing supported the applicant's case in the sense that although they did not exclude the respondent, they left him within a relatively wide statistical band of the population. Having canvassed the authorities on the proper inference to be drawn from a refusal to under parentage testing, he concluded that:

> "...the refusal, without explanation, by the respondent to participate in the second parentage test order is a striking and significant circumstance".[36] (My underlining.)

In ***G v H*** [37] a refusal to comply with a parentage testing order initially led to a result different to that in ***Re C (No 2)*** but was reversed on appeal.

There the applicant (H) had been a prostitute at the relevant time. She gave uncontroverted evidence that she had always used a combination of three different contraceptive methods with her customers. She testified her relationship with G had been unpaid, personal and without contraception such that he was almost certainly the father of the child.

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34 *Re C (No 1)* (1992) FLC, 92-283. And note section 66W(5) *Family Law Act* 1975 (Com) which deals with the consequence of a failure to comply with a parentage testing order, stating the person "...is not liable to any penalty...but the court may draw such inferences as appear just in the circumstances".

35 *Re c (No 2)* supra, at 79, 106

36 ibid, at p.79, 108

37 *G v H* (1993) FLC 92-380

The trial judge found that G's refusal to be tested was unreasonable but not to such an extent as to create a sufficient presumption that he was the father. He found G was not the father.

On appeal by H, the Full Court of the Family Court reversed that decision, taking the view, inter alia, that the "just inference" to be drawn from the refusal to undergo parentage testing must take into account the probative quality of the evidence which G was refusing to provide.[38] On the one hand it might completely refute the allegation that he was the father (by excluding him); on the other it might -

> "...conclusively demonstrate that he is the father..."[39]

In his judgment, Strauss J set out the following quotation from an article "DNA Paternity Probabilities" (1990) 24 Family Law Quarterly 279, by Professor D H Kaye, at page 303-4:

> "While I have tried to show that the difference between the probative value of DNA findings and more established genetic tests for parentage is one of degree, not kind, I should add that the degree to which genetic testing now can probe paternity may be sufficient to warrant qualitative changes in legal practice. For example, although the paternity index is not always easily calculated, the capacity of some DNA tests, especially in conjunction with tests of antigens and other gene products, to identify a biological father is so high that we are approaching the point where explicit statistical analysis can be relegated to the background. Today, exclusions rarely are interpreted in terms of a paternity index or a probability of paternity, presumably because these numbers are so close to zero as to give no more guidance to a judge or jury than a simple statement that if the test results are correct, then it is practically impossible for the tested man to be the father. Likewise, an inclusion for which the paternity index is clearly astronomical perhaps may be more profitably described as demonstrating that (it) is practically impossible for the putative father to be anything but the biological father. Given the difficulties the courts have had with devising appropriate standards for testimony about the paternity index and the probability of paternity, 'tis a consummation devoutly to be wished'."

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38 per Strauss J, ibid, at p.79,941

39 per Strauss J, ibid; and Wilczek J described the tests as "...a way of determining with almost absolute certainty whether he really is (the father) or not...", at p.79, 942.

His Honour had earlier [40] adverted to an affidavit from Professor Dale, a "Genetic Engineer", tendered before the trial judge, and which had not been challenged either by cross-examination or other evidence. In that affidavit the Professor had asserted -

> "The accuracy of DNA fingerprinting is usually in the order of 99.99 percent or greater. This is calculated from the number of different loci that are tested for and the frequency of the alleles detected. It is impossible to achieve a probability of 100 percent....
>
> If an error did occur in paternity testing then it would normally result in the person who was the father being shown as not being the father rather than the other way around."

Thus, the trial, the appeal to the Full Court and the subsequent appeal to the High Court [41] all proceeded on the basis that evidence was uncontested.

Although the members of the High Court took a different view than that of the Full Court - and, indeed, disagreed amongst themselves - they all came to the conclusion that the result arrived at by the Full Court was correct, the majority holding that the "just inference" to be drawn under section 66W(5) *Family Law Act* was that it was more probable than not that the outcome of the court-ordered test would be unfavourable to G and given the accuracy of the tests as confirmed by the evidence, the finding necessarily followed that on the balance of probabilities G was the father.

Whatever the jurisdiction, it is clear the prospect of demonstrating expert opinions based on the interpretation of DNA test results ought not to be admitted in evidence, or are at least unreliable, will be negligible unless the party seeking to challenge them is prepared and able to adduce expert evidence to that end. The case of ***R v Percerep*** [42] is a salutary example. There the appellant had been convicted of armed robbery and other offences. At trial, there was a voir dire on the admissibility of the prosecution's DNA profiling evidence.

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40 ibid, at page 79, 936.
41 *G v H* (1994) 68 ALJR 860; 124 ALR 353; (1994) FLC, 92-504.
42 ***R v Percerep*** [1993] 2 VR 109; 65A.Crim.R.419.

That evidence was to the effect that matches were identified at 3 separate loci between DNA samples from the accused and samples connected with the crime scene. One witness also asserted that the blood group was the same in each instance, that being a group shared by 38% of the population. That witness stated that the 3 matching DNA profiles occurred not more frequently than 1:650 persons. Taking into account the common blood grouping as well, the frequency became not more than 1:1,600 persons.

In cross-examination the prosecution experts conceded that opinions contrary to those they had expressed were held by some others in the scientific community, but they maintained the correctness of their own conclusions. No evidence to the contrary was called by the accused on the voir dire, nor was there any challenge to their scientific expertise whether generally or in the fields of statistics and population genetics.

On the appeal against the trial judge's refusal to exclude the evidence, the applicant had to accept that by asking the judge to exclude the evidence in the exercise of his discretion the defence had conceded that it was admissible.

The Victorian Court of Criminal Appeal in disposing of this ground of appeal said -

> "what was suggested was that the finding that the impugned evidence had probative value was not open to the judge. We disagree. The lack of any real challenge to the witnesses' qualifications; the maintenance of their opinions under cross-examination and the lack of opposing evidence lent a degree of inevitability to the judge's finding".[43]

A more recent reported Australian case on DNA evidence is ***Jarrett,*** [44] a decision of Mullighan J in the Supreme Court of South Australia. There the accused was charged with the murder of a 72 year old woman. She had been assaulted, raped and stabbed in her own home, where she lived alone. She had died of heart failure during or soon after the attack.

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43 65 A.CRIM.R. 419 AT 425

44 ***Jarrett*** (1994) 73 A.Crim.R. 160

Blood and other samples, including semen identified from a high vaginal swab, were taken from the deceased, her clothing and around the house.

Police investigations established that 17 men were known to have gone to the house for various reasons in the months leading up to the crime. The accused was one of them. He was employed by a contractor whom the deceased had engaged to clean and paint her roof.

All 17 men were interviewed and on request, provided blood samples.

Dr Angela van Daal [44A] of the State Forensic Science Centre undertook a DNA analysis of the samples and concluded that of all of the men who had given blood, only the accused could not be excluded as the donor of the semen. Because of the type of DNA analysis used (Polymerase Chain Reaction ("PCR") testing) she was also of the opinion that the chance of some person other than the accused being the donor of the semen - and therefore the murderer - was less than one in a million. That latter conclusion was based upon her knowledge of population and qualitative genetics.

On the basis of this information the accused was further interviewed by the police and subsequently charged. Thereafter, additional samples were taken of his blood together with hair from his arms, chest, scalp and pubic area.

These too were analysed by Dr van Daal.

The tests were subsequently repeated by a Dr Sajantila in Helsinki, Finland, who reached the same conclusions.

At trial the Crown sought to lead evidence from Drs van Daal and Sajantila and a Professor Chaseling, as to the frequency in the population of the combination of the 4 genotypes of the accused. The professor claimed expertise in applied statistics and quantitative genetics. Applying the product or multiplication rule she had concluded the frequency of the combination of the accused's genotypes appearing in the population as less than 1:899,229.

44A Assistant Chief Scientist, State Forensic Science Centre, Adelaide. See her article on RFLP and PCA profiling "DNA Profiling" in Australian Lawyer, Vol 31, No 8 September 1996.

On the voir dire the accused challenged the Crown expert evidence by calling two witnesses, a population geneticist, Dr Mitchell, and a forensic biologist, Dr Harding. The latter was critical of certain of the methods and procedures employed by Dr van Daal and suggested her results and interpretations were unreliable as a result. Mullighan J noted that Dr Harding had not himself undertaken DNA analysis of any of the samples and so it was not a case of suitably qualified experts obtaining different results. In his Honour's view there was no reason to apprehend that Dr van Daal had conducted her work incompetently or that unreliable results were obtained by her.

Likewise, with respect to the statistical frequency evidence there was no reason to conclude that Professor Chaseling's approach or methodology were wrong or had produced a result which could be inaccurate and misleading. All that may be said at that stage was that the evidence of Professor Chaseling and Dr Mitchell was in conflict.

The defence had also argued that there was a "threshold test" for the admissibility of expert evidence, which did not involve the exercise of discretion. That was the approach taken by Schreindlin J in the Supreme Court in ***The People v Castro*** .[45] In essence it would involve the trial Judge determining whether the laboratory substantially performed the scientifically accepted tests and techniques, yielding sufficiently reliable results to be admissible as a matter of law. In relation to the statistical frequency evidence, the "threshold test" would involve determining whether the views of the expert were sound.

Mullighan J did not accept these arguments. He started from the proposition that all evidence which is relevant is admissible unless excluded by a particular rule of evidence or it is within one of the well-known grounds for exclusion in the exercise of judicial discretion. [46]

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45 *The People v Castro* 545, N.Y.S. 985 (1989)

46 *Jarratt*, supra at p. 169

Expert evidence falls into no different category, said his Honour:

> "Once it is determined that expert evidence is relevant to a fact in issue, and there is no reason on policy or discretionary grounds for its exclusion, it should be admitted even though it is contested and there is apparently credible expert testimony to the contrary...."[47]

Once admitted it is a matter for the jury, properly and adequately directed, to decide in the context of all the evidence in the case, whether the evidence should be accepted [48] and, of course, not only what weight should be given to it but what (if any) inference(s) may ultimately be drawn from it.

Mullighan J considered ***Lewis*** to be distinguishable [49] and expressly disagreed with the view of McInerney J in ***Tran*** that (relevant) expert evidence could be excluded on the ground that it -

> "would have a tendency to produce a misleading and confusing impressing for the jury and further that they would not be capable of determining the issue raised by the evidence."[50]

His Honour reiterated that in the context of the case before him there could be no reason to exclude admissible evidence except in the exercise of discretion – and the mere fact the evidence of the experts conflicted was not sufficient justification for that.

In similar vein, Mullighan J distinguished the situation in ***Lucas*** noting in particular that in that case there were unsatisfactory aspects of the DNA analyses, there were difficulties which arose in the true interpretation of them and there was no evidence as to the frequency in the population of the genotypes said to establish the alleged consistency. (That last point, of course, was critical, because without that evidence the results of the DNA analysis were of no evidentiary value at all).

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47 ibid, p 169
48 ibid, p 171
49 ibid, p.172
50 ibid, p. 173

In a separate judgment [51] Mullighan J dealt with a defence objection to the admissibility of evidence of a DNA database.

The objection and the ruling turned on compliance with section 59b *Evidence Act* 1929 (SA) which makes specific provision for the admissibility and use of computer output in civil or criminal proceedings in that State subject to compliance with certain conditions. [52] His Honour concluded the conditions had been complied with and the evidence was accordingly admissible in that form.

The database contained the results of independent genotypes detected in the various samples sent to the SA State Forensic Science Centre since 1991. It was that database upon which Dr van Daal and the other Crown experts relied to express their opinions as to the frequency in the local population of combinations of genotypes.

Jarrett has recently been followed in an unreported Tasmanian case in which the results of DNA tests on biological samples which had been retained from a previously unsolved killing some 20 years or so earlier were held admissible after a voir dire which went for some weeks. The accused thereupon changed his plea to guilty.

In similar vein to Mullighan J's approach in ***Jarrett*** (although not in relation to DNA evidence) the Full Court of Victoria in ***Rozenes v Beljajer*** [53] made a declaration that a trial judge had erred in ordering the exclusion of certain prosecution evidence because of his conclusion that it was unreliable. The Full court held that there was a judicial discretion in a criminal case to reject any evidence on the ground that its admission would be unfair to the accused but there was no discretion to exclude evidence on the ground of its unreliability. The relevant discretion in the latter circumstance is that which enables exclusion because the probative value of the evidence is disproportionately outweighed by its prejudicial effect. Thus, the Court held that evidence which is probative should go to the jury despite its infirmities,

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51 ***Jarratt*** (1994) 73 A.Crim.R. 160 at 183

52 The terms of the relevant provisions of section 59b *Evidence Act* 1929 (SA) are set out at p.184-5 of the judgment. There is no equivalent provision in the *Evidence Act* 1906 (WA).

53 ***Rozenes & Anor v Beljajer & Anor*** (1994) 126 ALR 481

accompanied by the trial judge's directions concerning the considerations, both general and particular, affecting its reliability.

Likewise in ***Roughley*** [53A] the Tasmanian Court of Criminal Appeal upheld the admission of the complainant's testimony in a trial of charges including aggravated sexual assault notwithstanding that it had been hypnotically induced. The appellant had contended it was inadmissible or alternatively should be excluded in discretion because it had not been shown to be reliable. The Court (Cox J dissenting in part) held there is no legal basis for a proposition that there is a prerequisite for the admission into evidence of relevant post-hypnotic evidence that it must be shown to be reliable: matters concerning possible unreliability of evidence are for the jury to weigh upon.

Roughley was followed by Underwood J in ***Sparkes*** [53B], his Honour holding that the evidence of the complainant who had undergone post-traumatic hypnosis was not by reason of that fact inadmissible as a matter of law. In that same case Underwood J also admitted evidence of a DNA analysis.

The complainant had been subjected to a particularly vicious and degrading rape in October 1983. In April 1992 DNA was extracted from cells found on the pants worn by the complainant on the night of the attack. In mid-1995 the forensic scientist was given two pieces of cloth cut from the crutch of the jeans worn by the complainant. He also received samples of blood from the complainant, her boyfriend and the accused (taken in July 1995). A differential extraction process was carried out to separate semen from other cells. DNA was then extracted by the PCR technique. (An earlier attempt using RFLP had been unsuccessful.)

Despite the differential extraction, the extracted "female" specimen produced DNA profiles of at least three people - two were consistent with the complainant and her boyfriend; one was consistent with the accused or 4.4% of the Tasmanian population. Although the differential

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53A ***Roughley*** (1995) 78 A Crim R 160 - cf the NSW Court of Criminal Appeal in ***Tillott*** (1995) 38 NSW LR1; 83 A Crim R 151, in which that Court held there is an obligation on the Crown to show such evidence is "safe" to admit, although it is not inadmissible per se.

53B ***Sparkes*** (1996) 88 A Crim R 194.

extraction process is designed to separate the male cells from the female cells it is not always entirely successful. If the sperm has degraded, some of the DNA may have escaped and contaminated other cells.

The "male" jean stains revealed a mixture of DNA specimens from at least two people: one matched the boyfriend's profile, the other matched that of the accused (or 4.4% of the Tasmanian population).

All the samples were sent to the Victorian Institute of Forensic Medicine.

PCR was used on each to reproduce DNA at five different, independent genetic locations. The results of the process were placed on a gel and electrified to illuminate the allelic ladders. The observations then made were statistically applied to reach a conclusion that if it was assumed the boyfriend was one of the contributors to the male sperm, and if it was assumed there were only two male contributors,

> "... the other contributor was the accused or one in 128,000 people"

If statistical error was conservatively applied to those figures on the basis that the confidence limit was separately applied to each system used in the PCR, the figure of 128,000 reduced to 8000.

No submission had been made that the DNA evidence was inadmissible as a matter of law and Underwood J held there was no reason to exclude it in the exercise of his discretion.

There was a similar result in another voir dire ruling earlier that year in ***Milat*** [53C] in which on his trial for seven "backpacker murders" the Crown sought to lead against Ivan Milat evidence of DNA profiling from which it wished to show that blood on a piece of cord found in Milat's garage was, or was consistent with, the blood of one of the murder victims. Three different databases and two different procedures (RFLP and PCR) were relied on, in relation to eight genetic markers. The evidence was admitted, Hunt CJ at CL holding that the sizes and makeup of the databases used were statistically valid provided they were understood in the context of the 95% "confidence limits" reached, which

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[53C] ***Milat*** (1996) 87 A Crim R 446.

produced a range for such a chance from as low as 1:54,000 to as high as 1:220,000.

Significantly Hunt CJ described the effect of the DNA evidence as establishing

> "...only that the blood on the cord *could* be that of the deceased, in the sense that no test has excluded the blood as having come from the deceased; that evidence does *not* establish that it is in fact her blood (***Green*** , unreported, Court of Criminal Appeal, NSW, File No 060408/91, 26 March 1993 at p.9. The description originally given to DNA profiling by the media, that it was "genetic fingerprinting" was for this reason a misleading one). Where a number of blood tests - each of them operating independently of the others - have established a match in that sense, the inference is that the greater the number of such matches the less the chances that the blood has come from anyone other than the deceased (***Pantoja*** , unreported, Court of Criminal Appeal, NSW, File No 60718/1995, 6 February 1996 at p.11). Very little more could be gleaned from such matches alone." [53D]

The ruling in ***Milat*** is instructive because it turned principally upon the issue of statistical probability and the statistical validity of the databases used.

The database for the RFLP results (at two markers) was compiled from the tests of 500 people who had donated blood at the Red Cross Blood Bank over a short period.

The database for the PCR results at one marker was compiled from the testing of 409 people involved in criminal casework. That category included convicted criminals, victims and suspects who had not been convicted.

The database for the remaining PCR results at 5 markers was compiled from 402 people - 205 from the Red Cross and 197 involved in criminal casework.

Counsel for Milat challenged the statistical validity of the databases.

[53D] ibid, at p.447.

Hunt CJ accepted, on the basis of the United States literature and because biologically they related to different chromosomes, that the eight genetic markers were statistically independent of each other. The Crown was accordingly entitled to demonstrate what the probability was that there would have been a match at all eight markers by chance, and to do so by reference to the three databases used, if they were statistically valid.

One proposition upon which the prosecution relied was that although the precision of the figures produced is dependent upon the size of the sample - in the sense that the larger the sample the greater will be the precision - a smaller database is not any less statistically valid provided it is large enough. The prosecution expert said that in his view a (minimum) database of at least 200 is required. However, there was evidence to show that a more recent widely accepted scientific view was that the acceptable minimum number was "several hundred" persons, and in further evidence it was suggested databases of 400-500 people would be regarded as adequate.

Since all three databases here met even the more recent standards Hunt CJ was prepared to accept them.

However he also observed [53E] that:

> "The statistical validity of any database also depends upon whether it can be said to be representative of the general population, and the degree by which any database can be said to be so representative depends in turn upon whether the persons tested have been selected at random - whether each person in the population has had an equal chance of being selected."

In that case it was accepted that the three sources of blood tested here could not be said to be truly random but it was demonstrated they could nonetheless fairly be described as representative. That was demonstrated by showing there was no significant statistical difference between them and other comparative DNA databases used in Australia and overseas.

53E ibid, at p.450.

His Honour then turned to another element of the estimate of the probability that the DNA of another person within the general population would match the DNA of the deceased at all eight markers, namely, that the match occurred by chance or coincidence. This was described as the "confidence limits" to the estimate. He pointed out that unless the whole population were to be tested no estimate could ever be 100% correct. The confidence limits for any estimate depend upon the size of the database. The Crown expert was of the belief there that 95% confidence limits should be the minimum required. Applying that to the results there produced a range for a chance match at all eight markers from a low of 1:54,000 to a high of 1:220,000. The figure of 1:118,000 was the "central point" (although of course not a mathematical mean).

I am aware of only two criminal cases in Western Australia in which DNA evidence sought to be led by the prosecution has been actively challenged by the defence.

The first was in March 1993. In the course of committing a sexual offence in Norseman the offender left semen on the victim's clothing. There was no other evidence linking the accused to the crime, however the DNA analysis showed a match at 4 loci between the DNA from the crime scene sample and that from the blood of the accused.

Mr L Webb from the State Health Laboratory calculated the probability of a chance match in 2 loci was 1:26,896. Another Crown expert, Dr Focareta, estimated the probabilities of that at 1:59,000. Both experts relied on a South Australian genetic database comprising 740 unrelated individuals in respect of one locus and 520 individuals at the other. The reason they both relied only on those 2 matches was because there was no data on the frequency of genotypes at the other 2 loci.

Dr Linc Schmidt was called for the defence on a voir dire before Walsh J. He drew attention to several particular problems to do with the database relied upon by the Crown experts, including the lack of information about the source of the details recorded, the fact that the racial background of the accused was not known and that the racial composition of the town of Norseman was unknown. Overall, there had to be very great doubt as to the accuracy or otherwise of the statistical probabilities involved – and hence as to the chance of a random match.

At the conclusion of Dr Schmidt's evidence the Crown Prosecutor conceded the DNA evidence was inadmissible because of the problems with the probability evidence. That case was the subject of a short article in 'Brief' in April 1993. [54]

The other case was ***The Queen v Buckland,*** heard in February 1995. Buckland was charged with wilfully murdering his defacto wife Victoria Robinson in May 1993 in the bedroom of their home at Koondoola. No body had been found. She had given birth to a baby of which he was the father, only 3 1/2 weeks before she disappeared. He told police and others that she had simply walked out on them both, for reasons it is not necessary to mention here. There was evidence (which he denied) from two of Buckland's close associates, that he had admitted to them that he had killed her, put her body in the boot of her car and buried it in the scrub at Yanchep.

In September 1993 police investigators collected and submitted to the WA State Health Laboratory a number of items including a doona and pillow from Buckland's bed and a small stain on a chrome strip found in the boot of his car.

The immediate obstacle for the scientists was that because they had no body nor any blood or tissue sample known to be from Victoria Robinson they first had to determine what her DNA genotypes were in the specific search loci.

What they did was to analyse blood samples from each of Ronald Buckland, the child of him and Victoria Robinson and the parents of Victoria Robinson.

Using PCR testing, it was determined that a child of the victim's parents, who is also the mother of the baby of whom Buckland was the father, could have one of 12 genotypes.

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54 "DNA Profiling in Western Australia "Richard Utting, *Brief*, April 1993, p.9.

A detailed explanation of how that conclusion was arrived at would be well beyond the scope of this discussion. Very broadly however, it worked this way:

- For the 3 loci tested, a child of Victoria Robinson's parents ("the subject") would have to have one of 64 possible genotypes.

- If the subject was also the mother of Victoria Robinson's child, those 64 possibilities were reduced to 24.

- Finally, given Ronald Buckland's genotypes at the relevant loci, only 12 of the original 64 possible genotypes which must have come from the subject, remained.

As it happened the same genotype was identified in the samples from the doona, pillow and chrome strip.

Using a Victorian database, the experts expressed the opinion that particular genotype was found in about 1 in 1,300 people in the general population.

Thus, without the parentage results already obtained here, that would ordinary have been reported as one in 1,300 chance that this genotype of Victoria Robinson's DNA would match a random sample from the general population.

However, here it was not in fact known that she had that particular genotype: all that was known was that she had a 1:12 chance of having it.[54A]

The Crown expressed the end result as being that she was 108 times (ie 1,300 ÷ 12) more likely to be the source of the DNA on the doona, pillow and chrome strip than was some person at random from the general population.

54A A similar process of comparison was used in ***Milat***, supra, where again, the Crown did not have a sample of blood from the decesed. The comparison was made with the blood of her parents and the finding was made that the blood on the cord was consistent with that of a child of theirs.

All of this evidence gave rise to many issues on the voir dire, the end result of which was that the trial judge (Pidgeon J) ruled that he would exclude that portion of the evidence relating to population statistics and the frequency of the relevant genotypes in the general population. Given that ruling the defence withdrew the objection to the balance of the DNA evidence, with the consequence that it was eventually left to the jury on the basis that all the DNA evidence established was that there was a one in 12 chance that the blood on these items was consistent with the blood of Victoria Robinson, ie, that it *could* have been her blood.[55] This was reflected in his Honour's directions to the jury on this issue, when he told them they would most likely find the DNA evidence of no real assistance.

As recently as May 1997 the media reported[55A] that Western Australian police have resorted to DNA as a primary investigative tool in their enquiries into allegations of multiple incest offences. A woman and her father in a southwestern town had been charged, she with 3 counts of incest by a female over 18 years of age and 2 counts of sexual penetration of a lineal relative. Her father was charged with 3 counts of incest and 2 of sexual penetration of a lineal relative. According to a media report police believe her father could also be the father of as many as 5 of her 8 children. Some of the children are said to have medical defects and one to have died at an early age from a genetically-related medical condition.

When the woman was charged her children were taken into departmental care. The police sought permission from the department to get blood tests from the children, but before that could be arranged a court ordered the return of the children to their mother, who refused to allow blood testing.

The police then obtained a search warrant under which they seized hospital records showing the results of the children's Guthrie tests.[55B] Those results have been sent for DNA analysis. Police are reported to believe that analysis

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55 NB: Note the different formulation: not that there was a 1:12 chance she was the source of the blood.

55A Steve Pennells "Baby Test Cards Seized", *The West Australian*, Sat 24/5/97.

55B "Guthrie" tests are routine tests on newborn children to identify possible post-natal problems or medical conditions.

"... will determine if (the man) is the father of several of his daughter's children"

The preliminary hearings are listed for hearing in July 1997.

Much of the academic writing [56] on the DNA evidence tends to suggest that Australian courts are adopting the test for admissibility of novel scientific or expert evidence enunciated in 1923 in the United States in ***Frye v United States*** .[57] That test requires the relevant principle or technique to be sufficiently established to have gained general acceptance in the particular field to which it belongs. [58] As Ian Freckleton has pointed out [59] it has in fact come under considerable criticism in the United States for essentially being too conservative and tending to deny to the courts the benefits which new scientific advances may bring.

As can be discerned from the Australian cases already referred to, the development of new DNA techniques has been proceeding apace even over the last few years and in principle at least the technology appears now to have been generally accepted by the scientific community – and hence by the courts, at least to the extent sufficient to have such evidence left to the jury. But that does not mean DNA evidence will be admissible or ought to be admitted in a particular case. That will obviously depend upon what exactly that evidence is and, importantly, whether the specific technique has the necessary scientific recognition.

The form of DNA analysis most likely to be relied upon presently is PCR, which has the considerable advantage of being able to produce results from minuscule quantities of DNA.

No matter how simple or how sophisticated the technique there will always be areas of potential error or misinterpretation.

Possible problems with both RFLP and PCR testing are usefully discussed by Dan L Burke in "DNA Identification: Possibilities and Pitfalls

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56 eg Freckleton "DNA Profiling: Forensic Science under the Microscope" (1990) 14 Crim.L.J. 23,30.

57 ***Frye v United States*** 293 F.1013 (1923); and see Sylvester and Stafford " Judicial Acceptance of DNA Profiling" FBI Law Enforcement Bulletin, July 1991, p.26.

58 ***Frye v United States*** at p.1014.

59 (1990) 14 Crim. L.J. 23 at 32.

Revisited". [60] For RFLP these include "stale" batches of restriction enzymes not completely digesting a DNA sample; improper conditions causing probes to bind to the wrong band; bands not transferring properly from gel to fitter because of bubbles or flaws in the filter; or simple human error, such as operators mislabelling or accidentally mixing samples. Spurious bands may appear (and perhaps incorrectly be read as a "match") as a result of bacterial contamination of the sample.

DNA bands do not always migrate to exactly the same position in the electrophoretic gel due to minor variations in gel density, salinity of the solution, electrical voltage and so on. This is called "Band Shifting". It can be exacerbated where forensic samples are involved if they are contaminated. Ultimately, if band shifting is thought to have been possible that must be established and/or allowed for, thus introducing more scope for human error in what is essentially, an exercise in subjective comparison. And as Dan Burke points out [61]

> "There is a tendency for humans to see only what they expect to see."

Which is a tendency with which most trial lawyers are familiar.

Whilst PCR testing may be done with much smaller samples, it uses single-locus probes and so lacks the discriminating features of RFLP testing. In an endeavour to overcome that initial limitation, DNA fragments are amplified thus allowing electrophoretic separation. However that process then becomes subject to bandshifting and the other problems already mentioned.

More significantly, contamination of the PCR sample may result in the amplification of spurious DNA bands; the enzyme may not always replicate the sequences with complete fidelity, and there are other potential technical problems quite apart from the separate issue of population statistics and interpretation.[62]

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60 Dan L Burke "DNA Identification: Possibilities and Pitfalls Revited" 31 Jurimetrics Journal, Fall 1990, p.53.

61 ibid, at p.63

62 Such as abnormal or unreliable results obtained because of the way the sample was treated before the laboratory received it: see Simon J Young "DNA Evidence - Beyond Reasonable Doubt? (1991) Crim.L.R.264.

Burke also points out that despite the considerable hyperbole, DNA identification testing is clearly not infallible either in theory or practice. As he explains [63] -

> "The probability of a random match cannot simply be one in 30 billion, or one in 100 million. It cannot even be one in 24. It is, rather, one of these numbers qualified by certain assumptions and subject to a certain percentage or error. When the assumptions change, so do the numbers, as demonstrated in the ***Castro*** trial."

Quite dramatically different figures may be advanced in the interpretation of the same results. For example, Professor Bill Perriman of the Curtin University of Technology disputed certain prosecution claims in the O.J. Simpson trial in the United States. Simpson's blood matched that found near the bodies. The prosecution's expert witnesses asserted that the blood could have come from only one in 170 million people. Professor Perriman was of the view the figure was more like 3 in 100! [64]

Quite apart from reliability, the manner in which statistical conclusions about population genetics are sometimes expressed and the often enormous numbers involved, create their own serious forensic dangers.

An excellent explanation of some of these dangers is given by Balding and Donnelly in an article "The Prosecutor's Fallacy and DNA Evidence."[65]

Given a DNA match between a crime sample and an accused, a prosecution expert will then usually calculate the probability that an innocent individual, unrelated to the offender and chosen randomly from the appropriate population, will match the DNA profile taken from the crime sample. That is referred to as the *match probability.*

As Balding and Donnelly point out, there are 2 different questions which might be asked:

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63 ibid, p.80

64 An interesting and useful discussion of DNA testing in the context of the ***Simpson*** case and others may be found in the article "DNA on Trial" Macleans, February 6, 1995, p.56.

65 David J Balding and Peter Donnelly "The Prosecutor's Fallacy and DNA Evidence" [1994] Crim.L.R.711 - first discussed by Thompson and Schumann "Interpretation of Statistical Evidence in Criminal Trials" The Prosecutor's Fallacy and the Defence Attorney's Fallacy" Law and Human Behaviour (1989) Vol 11, 167.

(1) What is the probability that the accused's DNA profile matches the crime sample, given that he or she is innocent?

(2) What is the probability that the defendant is innocent, given that his or her DNA profile matches the crime sample?

They note that although it is the second question which is of direct relevance to the court, it is the first to which the expert's evidence will relate. (I would most strongly argue, that although the second question posed that way, is more directly relevant to the court, it ignores the fundamental onus of proof and hence, correctly formulated with that in mind, it would be "what is the probability the defendant is guilty given that his or her DNA profile matches that of the crime sample? In other words, the Balding and Donnelly formulation of the second question itself is a reversal of the onus of proof).

The answer to the first question is usually very small (eg 1:500,000); however the answer to the second question (as posed by Balding and Donnelly) will not necessarily be small. The critical point to appreciate is that the answer to the second question cannot be given without further information.

The *Prosecutor's Fallacy* consists of giving the answer to the first question as the answer to the second.

Thus, a statement that "the chance that DNA in the crime sample came from someone other than the accused is 1:500,000" is an example of the *Prosecutor's Fallacy*. The answer (to the first question) can go no further than the proposition that the chance that a particular individual unrelated to the accused will match the crime sample is 1:500,000.

Balding and Donnelly sound an important note of caution –

> "Even when the prosecution words its evidence so as to avoid the prosecutor's fallacy there is a danger that the jury will commit it inadvertently. That is, on hearing an expert mention a very small probability, or a large likelihood ratio, they may immediately assume that this proves the guilt of the defendant. This danger may be heightened by the general perception that DNA profiling is 'infallible'.

> When DNA evidence involving probabilities is presented, it is incumbent on the forensic scientist, and those adducing such evidence, to ensure, at the very least, that it is accompanied by an explicit warning against misinterpretation." [66]

The authors later proceed to discuss the *"Defendant's Fallacy"* . [67] That consists of ignoring identification evidence involving a trait on the ground that a large number of individuals share it. It may be of some evidentiary assistance to know that the accused has a particular characteristic which is shared by eg 500 other people in Western Australia – so long as it is thoroughly understood that it is not possible to come to a view whether or not there may be a common origin between the sample and the accused, solely on the basis of the DNA evidence.

In short, as Balding and Donnelly make clear -

> "...it is not within the domain of the expert witness to express an opinion as to whether the defendant was the source of the DNA in the crime sample." [68]

From the point of view of a criminal investigation or prosecution, the most powerful utility of DNA profiling remains its exclusionary effect. Thus, a suspect or accused whose DNA does <u>not</u> match the offender's profile <u>cannot</u> have been the offender. That point was dramatically made early this year in the case of Dr Sam Shepherd. [68A] Dr Shepherd's story inspired the television series and later the movie "The Fugitive". Dr Shepherd (who served 10 years for the murder of his wife) always maintained she had been beaten to death in their bedroom while she was asleep on a couch downstairs, that he was awoken by her screaming and fought her unknown assailant who left him (Shepherd) unconscious and escaped. A trail of blood through the house was thought by the prosecution to have been that of his wife which dripped off the murder weapon as Shepherd carried it through the house. The weapon was never found. Shepherd himself had no bleeding wounds.

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66 ibid, p. 717
67 ibid, p.719-720
68 ibid, p.721
68A The revelation of the DNA evidence and Dr Shepherd's story were the subject of an article by Cameron Stewart, New York correspondent for "The Australian", on 8/2/97.

Recent DNA tests on the 43-year old blood samples however have shown that it was not Mrs Shepherd's - there therefore had to have been a third (bleeding) person in the house at the time.

"The Fugitive" it seems, was indeed innocent!

The legal issues arising out of the forensic use of DNA testing whether as an investigative aid or as evidence are not confined to arguments about its admissibility or probative value.

It is obvious that such testing of a suspect or accused can only be done on blood, tissue or other body samples the taking of which is most likely to be invasive. [69]

The question of police powers to compulsorily require the provision of such samples or to take them by force from a suspect or accused, is extremely controversial, as is the collection and storage of such information in national or other databanks being established and maintained for the purpose of comparison.

Mass DNA screening has been widely used in Britain since 1986 when it resulted in the successful investigation of a rape-murder. The British Government subsequently opened a "DNA bank" for storage of hundreds of thousands of people who have been suspects or defendants.

In January 1996 mass DNA screening of blood or saliva samples from some 2000 men in Wales resulted in the arrest of a suspect for rape and murder of a 15-year-old Cardiff girl. The comparison was with a DNA profile from the assailant's semen.

In Perth, Western Australia, police have recently undertaken a similar exercise in their investigation of the still unsolved murders of Jane Rimmer and Ciara Glennon and the disappearance of Sarah Spiers, by taking voluntary saliva or blood samples from all Perth taxi drivers.[69A] This would seem to suggest the police already have a DNA sample from

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69 Hence they are often referred to as "intimate body samples".

69A Each of these young women disappeared from a popular night entertainment area at Claremont. Sarah Spiers has not yet been found. One popular theory was that a taxi driver may have been involved since the women were otherwise not likely to have gone in a vehicle with someone they did not know.

the offender and that DNA evidence is likely to be a feature of any trial if there is an arrest.

Considerable caution has to be exercised in such a process. The occurrence of a matching profile from those tested may sometimes be given far greater significance than it justifies. There may be a tendency to jump to conclusions about events without considering their typical frequency, or base rate. That has been described by psychologists as the "base-rate fallacy".

Where a mass population survey is used to screen for a matching DNA profile and one is found, the real statistical probability (or match rate) will not be simply 1:10,000 (or whatever the frequency is in which that profile appears in the general population, but it will be the match rate modified by the error rate ie the risk that the match between the specimen sample and the accused is in fact an error. Such an error could be due to one or more of many possible reasons, including accidental mis-labelling at the scene of the crime to error in handling the evidence or errors in the laboratory - and that will inevitably mean a greater likelihood of innocence (other evidence aside).

To illustrate [69B] by an over-simplification let us assume a DNA profile occurs 1:1000 - so 999 people in 1000 do not have that profile. Assume further that DNA typing of suspects produces incorrect results on 1/100 occasions. Now the table of possible results for a randomly chosen individual when compared to the forensic sample (assumed to be correctly recorded - which assumption may itself not be correct in a particular case), together with the probability, would then be:

Truth	match (1/1000)		no match (999/1000)	
recorded as	match (99/100)	no match(1/100)	no match (99/100)	match (1/100)
probability	1/1000 x 99/100	1/1000 x 1/100	999/1000 x 99/100	999/1000 x 1/100
=	~ 1/1000	1/100000	~1	~1/100

[69B] I gratefully acknowledge the assistance of Dr Linc Schmidt of the University of Western Australia for both this explanation and the illustration.

The two probabilities of interest here are the first and the last - 1/1000 and 1/100 - because they represent the way matches can be recorded. Under these conditions of random sampling, it is 10 times more likely when claiming a match, for this to be due to an error than being correct. This is because the base-rate of no-match is exceedingly high.

These figures it must be appreciated, while perhaps realistic a few years ago are no longer so. The match frequencies now may be more likely 1 in a million, and the error rates are probably lower, but perhaps considerably greater than 1 in a million! This is one of the reasons why repetition of typing and great care in the procedures for handling specimens is so important.

Several Australian jurisdictions have already given police express statutory authority for the taking of intimate body samples.[70]

Section 353A(2) *Crimes Act* 1900 (NSW) has until recently been relied upon as given authority to police to take non-consensual blood samples. However in ***Fernando v Commissioner of Police*** [71] the New South Wales Court of Appeal held that while the section permitted external examination by sight and touch it did not permit the taking of any part of the body, nor did it authorize what would otherwise be an assault. In the absence of clear language showing an intention to abrogate common law rights, the courts would not imply such a power. [72]

In a commentary on this case [73] Beverley Schurr suggests that -

> "The decision will lead to pressure for Parliament to give police clear powers to take non-consensual body samples."

The *Crimes Amendment (Forensic Procedures) Bill* 1995 (Com) has been introduced into the Federal Parliament and presently stands referred to the Senate Legal and Constitutional Committee for comment. If

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70 *Crimes Act* 1900 (NSW), S.358C; *Crimes Act* 1958 (Vic), S.464M; *Criminal Code Act* 1899 (Qld), S./259(3); *Criminal Process (Identification and Search Procedures) Act* 1976 (Tas), S.6(5); *Police Administration Act* 1978 (NT), S.145(3).

71 ***Fernando v Commissioner of Police*** (unreported) C.A.(NSW) CA 40761/94, 29/3/95, noted in (1995) 19 Crim.L.J.290

72 applying ***Coco v The Queen*** (1994) 179 CLR 472; 72A.Crim.R.32

73 (1995) Crim.L.J.291

enacted, it will insert a new part into the *Crimes Act* 1914 setting out extended powers for police to take intimate body samples from suspects and people in custody. It has been suggested that in its final form the Federal Bill may serve as a model for the States. The Bill has already been the subject of considerable academic and other comment. [74]

L W Roberts-Smith, QC
Wickham Chambers
27 May 1997

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74 See, eg Beverley Schurr "Contemporary Comment: Sensitive Tissues - The Model Bill for Forensic Procedures 1994" (1995) 19 Crim.L.J.32;
Beverley Schurr "Contemporary Comment: Forensic Procedures - An Update." (1995) 19 Crim.L.J.86.

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