DNA: Fundamentals to Familial Searching

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• Multiplex PCR kits
• Amplify STR regions of DNA
• 3 or 4 base pair repeat units
• Not diagnostic
Ten cells

One cells
• Expert software system
• Developed by Duncan Taylor (FSSA), John Buckleton (ESR) and Jo Bright (ESR)
• Based upon well accepted mathematical and statistical principles
• Takes all profile information into account
• Replaces the need for human interpretation
• Ensures consistency between scientists and jurisdictions
STRmix™

• STRmix uses what’s known as a “continuous” system
• Before STRmix™ we used a “binary” system
• STRmix™ considers all possible explanations and gives them a weighting
• The scientist determines the number of contributors and critically assesses the output
• Calculates a likelihood ratio with two alternate hypotheses
Like this.

$$\begin{align*}
T_{a,n,y,k}^l &= t_n \times A_k^l \times R_{y,k} \times B_k \times X_n \times e^{-d_{n,k}\left( m_{a,k}^l - \text{offset}_k \right)} \\
LR_C &= \frac{\sum_{q} w_q \cdot \Pr(S_q | H_1)}{\sum_{u} w_u \cdot \Pr(S_u | H_2)} \\
E_{an}^l &= \frac{TAP_{an}^l}{1 + SR_a^l} = \prod_{l} \prod_{a} \frac{\log \left( \frac{\bar{E}_a^l}{E_a^l} \right)}{0, \frac{C}{E_a^l}} \\
\log E_s | \log E_{(a-1)n}^l &= \mathcal{N}\left(0, \sigma_S^2\right) \\
\log E_a | \log E_{an}^l &= \mathcal{N}\left(0, \frac{\sigma_A^2}{E_{an}^l}\right) \\
E_{(a-1)n}^l &= \frac{SR_a^l \left( TAP_{an}^l \right)}{1 + SR_a^l} \\
\text{SR} &= (\beta_1 + \beta_{3i}) \text{allele} + (\beta_2 + \beta_0)
\end{align*}$$
Contact DNA = bad(variable) source of DNA
Probably multiple users

What will give a good result?

What items are the most probative/useful to the investigation?

Saliva = good source of DNA
Probably only one user
Research paper

Observations of DNA transfer within an operational Forensic Biology Laboratory

Duncan Taylor, Damien Abarno, Emily Rowe, Lauren Rask-Nielsen

Fig. 3. As Fig. 2, but showing an evidence recovery person, who appears to shed very little DNA.

Fig. 4. As Fig. 2, but showing an evidence recovery person, who appears to shed a lot of DNA.
DNA transfer

• Deposition can be effected by:
  - Duration, frequency and force of the physical contact
  - Type of item
  - Washing
  - Exposure to environment

• Limitations
  - Person 1 vs. 2 vs. 3; unable to determine who was the first or last person to touch an item
  - Persistence of DNA; unable to determine when DNA was deposited

• Contact DNA has a low success rate
  - Less than 8% for tools, weapons, plastic bags and vehicle swabs
  - The chances of successfully obtaining useable DNA from firearms is about 3%
Hierarchy of issues

- Guilt or innocence. Did the suspect rape the victim?
- Did the POI have intercourse with the complainant?
- Did the semen come from the POI?
- Did the DNA in the sample came from the POI?
Activity level evaluations can deal with exclusionary data

The evaluation of exclusionary DNA results: A discussion of issues in R v Drummond. Law Probability and Risk
Activity level evaluations can deal with exclusionary data
Where does this data come from?

Evaluation of multiple transfer of DNA using mock case scenarios
Mariya Goray, John R. Mitchell, Roland A.H. van Oorschot

The transfer of touch DNA from hands to glass, fabric and wood
Dyan J. Daly, Charlotte Murphy, Sean D. McDermott

Secondary DNA transfer of biological substances under varying test conditions
Mariya Goray, Ece Eken, Robert J. Mitchell, Roland A.H. van Oorschot

DNA transfer during social interactions
Mariya Goray, Roland A.H. van Oorschot

Assessment of individual shedder status and implication for secondary DNA transfer
R.K. Farmen, R. Jaghø, P. Cortez, E.S. Frøyland

The Recovery and Persistence of Salivary DNA on Human Skin
June Kenna, M.Sc.; Maureen Smyth, Ph.D.; Louise McKenna, Ph.D.; Clare Dockery, M.Sc.; and Seán D. McDermott, Ph.D.
Database

- Legislation in each state (CLFPA)
- SA database owned by Commissioner of Police
  - Management of database delegated to Director of FSSA
- National Criminal Investigative DNA Database (NCIDD)

<table>
<thead>
<tr>
<th></th>
<th>No. Profiles</th>
<th>% population</th>
</tr>
</thead>
<tbody>
<tr>
<td>South Australia</td>
<td>~160,000</td>
<td>~7</td>
</tr>
<tr>
<td>NCIDD</td>
<td>~1,200,000</td>
<td>~3.5</td>
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</tbody>
</table>
Familial Searching

- Crime scene profile doesn’t directly match anyone on the database
- Offender may be a relative of the person on database
- Search the database for someone who might be a relative of the person who left the crime stain
- Conducted in the UK and NZ
  - UK ~200 inv (27 prosecutions), NZ ~20 inv
- Used in SA
  - Very strict criteria
  - Complex application and approvals process
Legislation

“Commonwealth, state and territory DNA database legislation is currently silent on the permissibility of familial searching. The statutes provide for substantially similar provisions in terms of permissible use of NCIDD and state/territory databases, which do not expressly prohibit nor permit familial searching.”


“It appears likely that familial matching is permissible under Part 1D of the Crimes Act 1914 (Cth) as it currently stands. The picture across other Australian jurisdictions is essentially similar.”

The Grim Sleeper

• In May 2007, the murder of Janecia Peters, 25, was linked through DNA analysis to at least eleven unsolved murders in Los Angeles, the first of which occurred in 1985.
• A familial search identified Christopher Franklin, the son of Lonnie David Franklin Jr.
• Detectives then used a piece of discarded pizza with Franklin's DNA to make the link.
• Investigators found over 1,000 photos and several hundred hours of video of women in his home.
NCIDD Integrated Forensic Analysis

SMART RESEARCH DEVELOPS BONAPARTE FOR NFI

Bonaparte was developed as part of an assignment from the Netherlands Forensic Institute (NFI). Bonaparte uses a combination of domain knowledge (provided by the NFI) and powerful algorithms with which SMART Research has developed a model that can be used for identifying human beings through DNA profiles and family ties. The model has been integrated in the NFI working processes and is used on a daily base. With help of Bonaparte all victims of the Tripoli (2010) and the MH17 (2014) plane crashes have been identified. Additionally, a Dutch murder case (the Vaatstra case - 2012) has been solved and a serial rapist in Utrecht was tracked (2014).

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CrimTrac Agency and SNN sign contract for provision of Bonaparte

NIJMEGEN, The Netherlands — The Australian Commonwealth represented by the CrimTrac Agency and SNN have signed a contract for the provision of SNN's Bonaparte DNA matching software and associated support services as part of a National DNA Investigative Capability (NDIC). The contract is the corollary of SNN's successful bid on tender C14/147 issued by the CrimTrac Agency last year.
MPS

- Just starting to be used in operational labs
- Challenges with data, ethics, amount of DNA required, reproducible protocols, standardisation, link back to existing STR typing.
- Applications in:
  - Phenotyping
  - Ancestry
  - Identical twin discrimination
DNA identikits

Snapshot Prediction Results
Composite Profile
Predicted (■) & Excluded (✖) Phenotypes

Skin Color: 64%
- Light Olive / Dark Olive (97.6% confidence)
- NOT Fair / Very Fair / Dark (97.4% confidence)

Eye Color: 94.8%
- Brown / Black (96.0% confidence)
- NOT Blue / Green (95.99% confidence)

Hair Color: 95.8%
- Black (99.8% confidence)
- NOT Brown / Red / Blond (99.8% confidence)

Freckles: 12.4%
- Zero (99.1% confidence)
- NOT Few / Some / Many (99.1% confidence)

Sex: Male
Age: Unknown (Composite shown at age 25)
Ancestry: East Asian

Actual Photo

Snapshot Prediction Results
Composite Profile
Predicted (■) & Excluded (✖) Phenotypes

Skin Color: 54%
- Fair / Very Fair (99.6% confidence)
- NOT Brown / Dark Brown (99.3% confidence)

Eye Color: 64.1%
- Green / Blue (82.5% confidence)
- NOT Brown / Black (99.2% confidence)

Hair Color: 22.4%
- Brown / Blond (97.9% confidence)
- NOT Black (97.9% confidence)

Freckles: 69.3%
- Few / Some (25.0% confidence)
- NOT Zero (96.2% confidence)

Sex: Female
Age: Unknown (Composite shown at age 25)
Ancestry: Northern European

Actual Photo

Snapshot Prediction Results
Composite Profile
Predicted (■) & Excluded (✖) Phenotypes

Skin Color: 87.8%
- Light Olive / Dark Olive (98.6% confidence)
- NOT Fair / Very Fair / Dark (98.6% confidence)

Eye Color: 70.3%
- Hazel / Brown (99.5% confidence)
- NOT Green / Blue / Black (99.5% confidence)

Hair Color: 44.4%
- Blond / Red (98.8% confidence)
- NOT Black (98.8% confidence)

Freckles: 17.2%
- Zero (99.6% confidence)
- NOT Few / Some / Many (99.8% confidence)

Sex: Female
Age: Unknown (Composite shown at age 89)
Ancestry: European and Latino

Actual Photo
Forensic Genealogy

GEDmatch provides DNA and genealogical analysis tools for amateur and professional researchers and genealogists. Most tools are free, but we do provide some premium tools for users who wish to help support us with contributions. You will need to upload DNA and/or genealogical (GEDCOM) data to make use of the tools here. Registration requires your name, email and a password of your choice. Click HERE to register.

Log In

Email Address: 
Password: 

Log in

Not Registered? Click HERE

Forgot your password or wish to change your password? Click HERE

Site policy: Click HERE
‘Golden State Killer’ suspect in police custody after 40-year search

Man Arrested in 1987 Killing of Couple in Washington State

"Buckskin Girl" case: DNA breakthrough leads to ID of 1981 murder victim
Thank you