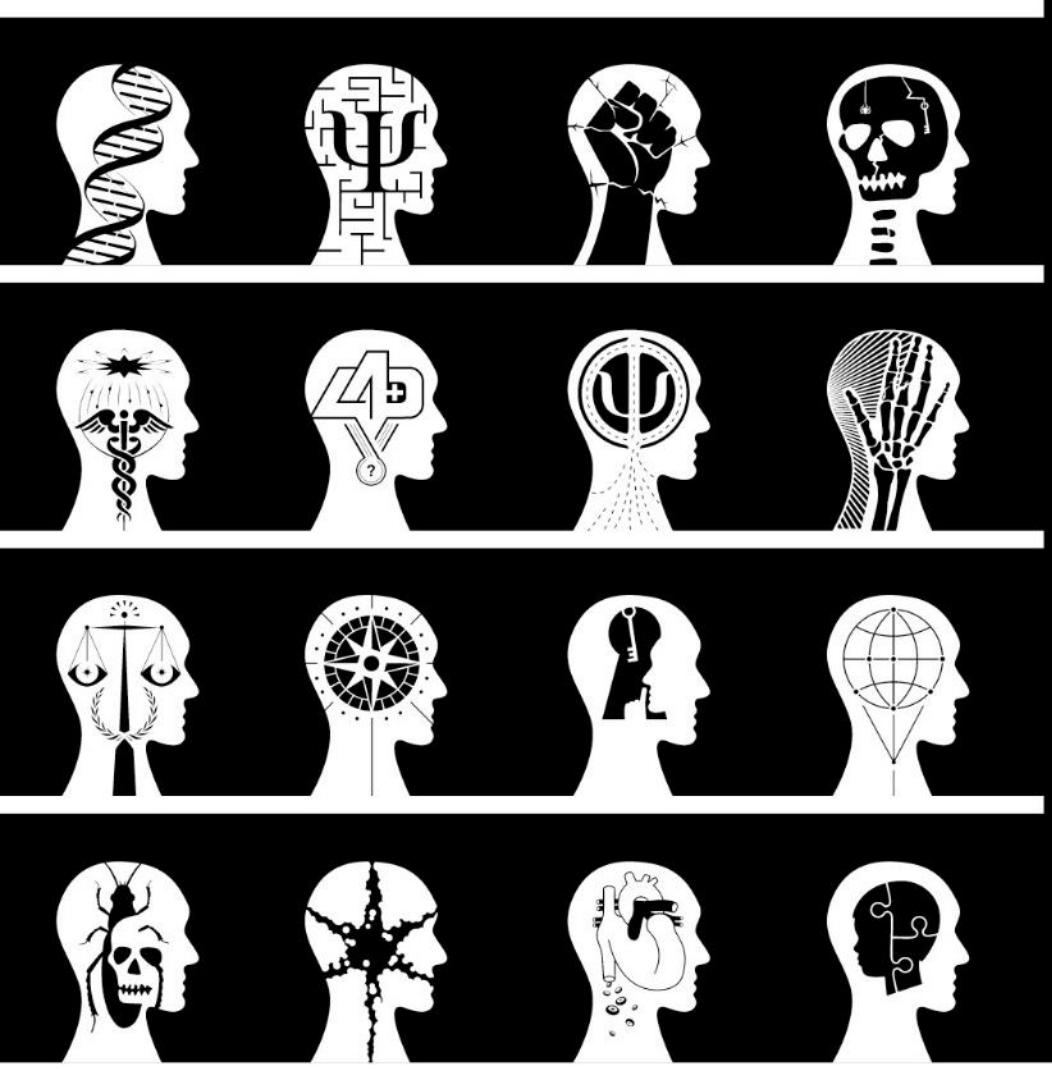


Centre Universitaire Romand

Médecine Légale

Using Public DNA Databases to help Identify Suspected Perpetrators of Crime

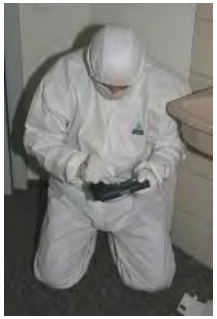
DrSc. Vincent Castella
PD, MER

Zürich, 28.02.25

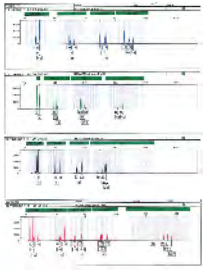
1. Classical use of DNA profiles in Switzerland
2. Investigative use of DNA in Switzerland
3. **F**orensic **I**nvestigative **G**enetic **G**enealogy (FIGG)
4. Conclusion

1. Classical use of DNA profiles in Switzerland

Comparison between DNA profiles (STR markers)

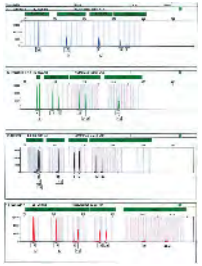


PCN 18 843513 94



Trace DNA profile

PCN 33 602770 42



Person DNA profile

The **Swiss DNA database** was launched in 2000, with the aim of associating traces and persons DNA profiles.

National DNA database at 31.12.24	
Person DNA profiles	166'222
Trace DNA profiles	127'610
Associations in 2024	
Trace-Person “hits”	**7’816 (150 per week)**

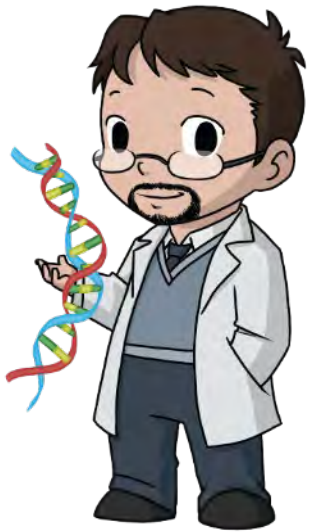
In 2024, 72% of the trace-person “hits” concerned thefts !

Various thefts (Art. 139*)	5635
Drug-related offences (Art. 19, 20**)	703
Damage to property (Art. 144*)	360
Robbery (Art. 140*)	195
Sexual acts including rapes (Art. 187-191*)	117
Assault (Art. 134*)	93
Simple bodily injuries (Art. 123*)	90
Murder, assassination and homicide (Art. 111, 112*)	88
Serious bodily injuries (Art. 122*)	84
Others	448

*Swiss Criminal Code, SR 311.0 / **Narcotics Act, SR 812.12
BiomID statistics from the Federal Office of Police

2. Investigative use of DNA in Switzerland

The aim of **investigative genetics** or “DNA intelligence” is to provide leads during the investigation



The **DNA Profiles Act** (SR 363) was revised in 2023 to extend the use of DNA in Switzerland

It now includes **Forensic DNA Phenotyping** and **Familial DNA searching**

Forensic DNA Phenotyping

VISAGE
VISIBLE ATTRIBUTES THROUGH GENOMICS

Forensic Science International: Genetics 48 (2020) 102336

Contents lists available at ScienceDirect

Forensic Science International: Genetics

journal homepage: www.elsevier.com/locate/fsigen

Research paper

Development and validation of the VISAGE AmpliSeq basic tool to predict appearance and ancestry from DNA

Catarina Xavier[a,*], Maria de la Puente[a,b], Ana Mosquera-Miguel[c], Ana Freire-Aradas[b], Vivian Kalamara[a], Athina Vidaki[c], Theresa E. Gross[d], Andrew Revoir[e], Ewelina Pośpiech[f], Ewa Kartasińska[g], Magdalena Spólnicka[g], Wojciech Branicki[f,g], Carole E. Ames[e], Peter M. Schneider[d], Carsten Hohoff[d], Manfred Kayser[c], Christopher Phillips[b], Walther Parson[a,e,h], on behalf of the VISAGE Consortium

[a] Institute of Legal Medicine, Medical University of Innsbruck, Innsbruck, Austria
[b] Forensic Genetics Unit, Institute of Forensic Sciences, University of Santiago de Compostela, Spain
[c] Department of Genetic Identification, Erasmus MC University Medical Center Rotterdam, Rotterdam, the Netherlands
[d] Institute of Legal Medicine, Faculty of Medicine and University Hospital Cologne, University of Cologne, Cologne, Germany
[e] Metropolitan Police Service London, United Kingdom
[f] Malopolska Centre of Biotechnology, Jagiellonian University, Krakow, Poland
[g] Central Forensic Laboratory of the Police, Warsaw, Poland
[h] Institut für Forensische Genetik GmbH, Münster, Germany
[i] Forensic Science Program, The Pennsylvania State University, University Park, PA, USA

153 SNPs

www.aging-us.com AGING 2021, Vol. 13, No. 5

Research Paper

Development of the VISAGE enhanced tool and statistical models for epigenetic age estimation in blood, buccal cells and bones

Anna Woźniak[1,*], Antonia Heidegger[2,*], Danuta Piniewska-Róg[3,*], Ewelina Pośpiech[4], Catarina Xavier[2], Aleksandra Pisarek[4], Ewa Kartasińska[1], Michał Boroń[1], Ana Freire-Aradas[5], Marta Wojtas[3], Maria de la Puente[2,5], Harald Niederstätter[2], Rafał Płoski[6], Magdalena Spólnicka[1], Manfred Kayser[7], Christopher Phillips[5], Walther Parson[2,8], Wojciech Branicki[1,4], VISAGE Consortium

[1]Central Forensic Laboratory of the Police, Warsaw, Poland
[2]Institute of Legal Medicine, Medical University of Innsbruck, Innsbruck, Austria
[3]Department of Forensic Medicine, Jagiellonian University Medical College, Krakow, Poland
[4]Malopolska Centre of Biotechnology, Jagiellonian University, Krakow, Poland
[5]Forensic Genetics Unit, Institute of Forensic Sciences, University of Santiago de Compostela, Santiago de Compostela Spain
[6]Department Medical Genetics, Warsaw Medical University, Warsaw, Poland
[7]Department of Genetic Identification, Erasmus MC University Medical Center Rotterdam, Rotterdam, Netherlands
[8]Forensic Science Program, The Pennsylvania State University, University Park, PA 16802, USA
*Equal contribution

Few cases handled so far !

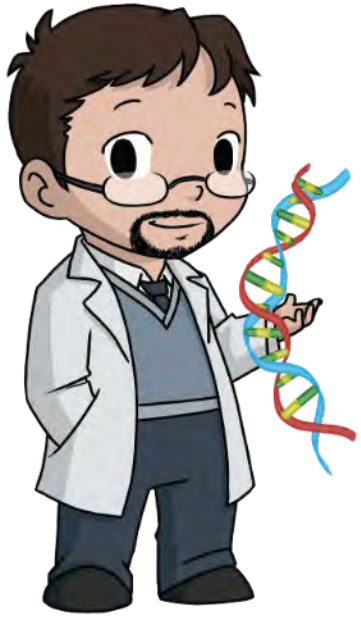
Familial DNA searching: 1/44 successful case since 2015

- In 2022, a **15-year-old girl was sexually assaulted** in Lausanne. Four samples were taken from her mouth, breast, bra and panties.
- A **male DNA profile** was obtained and sent to CODIS.
- **No trace-person hit**, but a trace-trace hit with a sample taken in the context of the rape of a prostitute in 2018.
- At the prosecutor's request, a **familial search** was performed :
  - 33 candidates for a parent-child relationship
  - 49 candidates for a brother relationship

Familial DNA searching: 1/44 successful case since 2015

- Investigators focused on the second man on the parent-child list. Aged 60 and known since 2004 for sexual assaults, he has **two sons** aged around 30, one of whom lived close to where the young girl was assaulted.
- A buccal swab was taken from this son. **His DNA profile corresponds to the DNA profile of the traces.**
- Investigators must confirm this lead. DNA is insufficient on its own.

3. Forensic Investigative Genetic Genealogy (FIGG)



The aim of **FIGG** is to help identify **criminals**, and **missing persons**, through relatives, using **public databases***

* alias genetic genealogy , Direct-To-Consumer, collaborative, recreative, commercial databases,…
For FIGG definition, see O Tuazon *et al.* Forensic Science International: Synergy 8, 100460, 2024

The "Golden State Killer" committed 12 murders and over 50 sexual assaults in California between 1973 and 1986. He was identified in 2018 with FIGG.

© Thomson Reuters Joseph James DeAngelo, 72, who authorities said was identified by DNA evidence as the serial predator dubbed the Golden State Killer, appears in a wheelchair at his arraignment in California Superior court in Sacramento, California, U.S., April 27, 2018. REUTERS/Fred Greaves

Paul Holes chased the Golden State Killer for 24 years

After 44 years of unsuccessful classical investigation, it took a group of 6 persons 4.5 months to "identify" Joseph DeAngelo

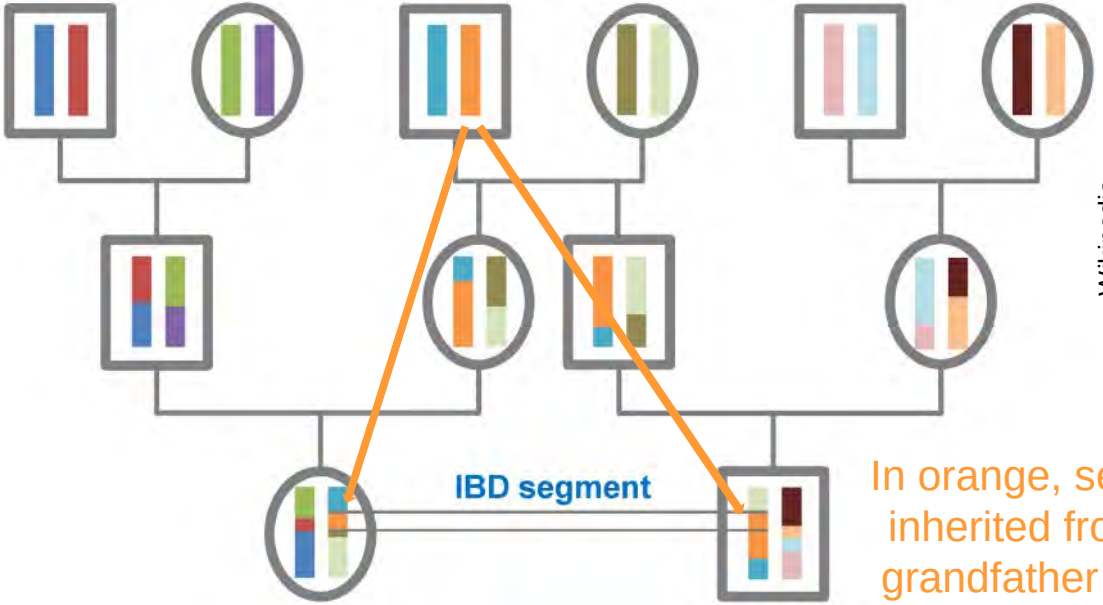
Barbara Rae-Venter pioneer in genetic genealogist and writer

A SNP genotype from a DNA sample from a sexual assault kit was loaded into GEDmatch database. It was associated with a **3rd cousin** of Joseph DeAngelo.

1. **Analyse** the crime scene DNA (targeted MPS sequencing, SNP microarray, WGS)
2. **Search database**, mainly GEDmatch PRO and FamilyTreeDNA to find associations
3. **Build a genealogy** using non genetic data (birth, marriage and death records, newspapers, social media,…)
   - Find the Most Recent Common Ancestor
   - Go forward to find all descendants
4. Reduce the list of candidates
5. Check the shortlist using classical forensic genetics and other means

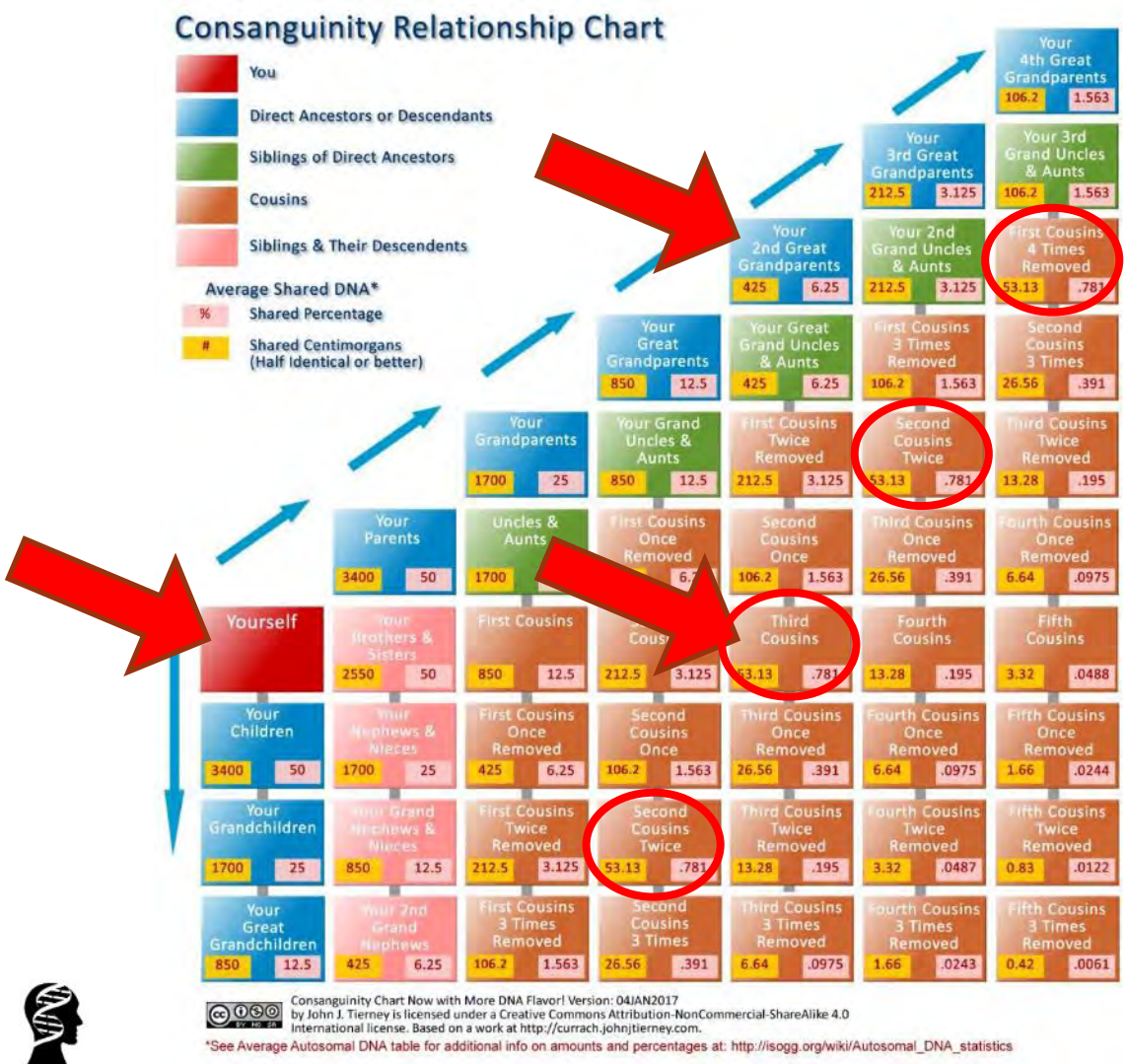
Associating individuals in genealogy databases

Recombination between homologous chromosomes occurs between each generation



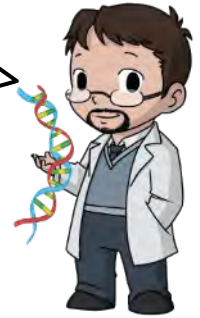
In orange, segment inherited from the grandfather by the cousins

The **length of the shared segments** (and other metrics) is related to the **number of generations** separating the individuals !



*See Average Autosomal DNA table for additional info on amounts and percentages at: http://isogg.org/wiki/Autosomal_DNA_statistics

For a **3rd cousin association**, genealogists go backwards four generations to find the common **great-great-grandparent**, then go forward to find all the descendants...



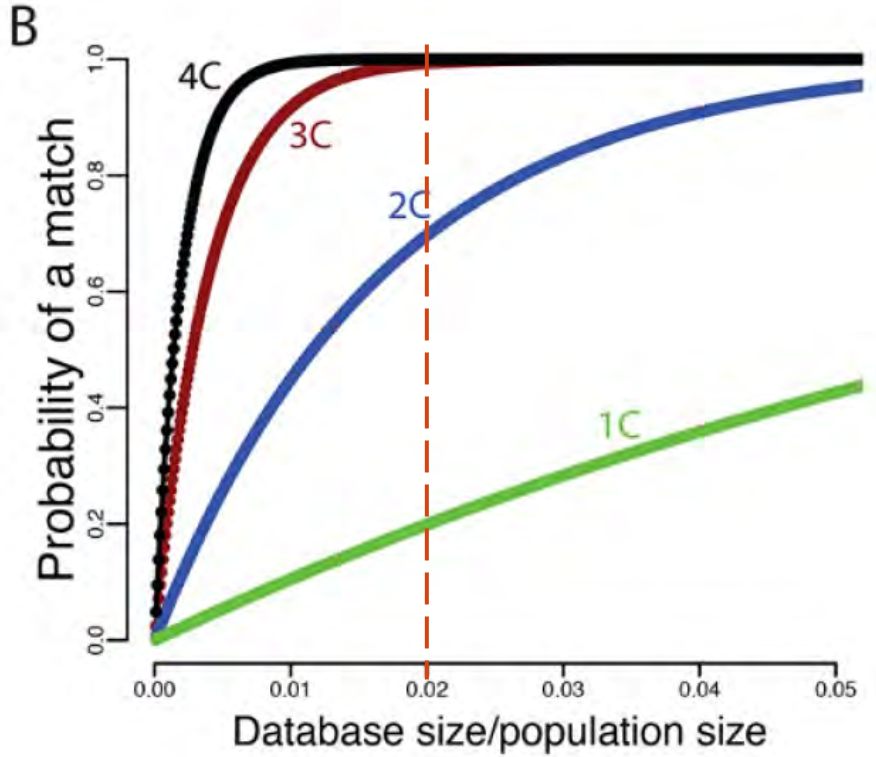
Relationship	Individual born in 1955 (Sweden)	Individual born in 2005 (Sweden)
Siblings	1.3	1.0
1st cousins	9	8
2nd cousins	65	32
3rd cousins	577	152
4th cousins	4935	1064

The most complex and time-consuming work falls to genealogists !

e.g., 1’000 individuals in 25 family trees for the Golden State Killer.

D Kling and A Tillmar. Forensic Science International: Genetics 42, 113-124, 2019

The chance of finding a parent using FIGG is high !

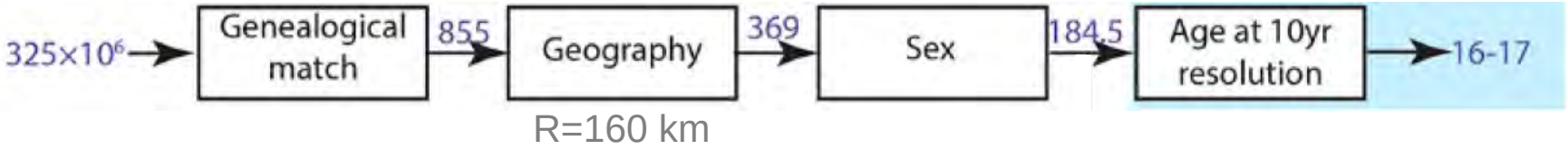


With only 2% of the population in a database, there is a 99% probability of finding at least one 3rd cousin of any individual in that population !

Y Erlich *et al.* Science10.1126/science.aau4832, 2018

Reducing the list of candidates

Simulation for a search in the US (325 millions inhabitants) using a database of 1.28 million individuals.

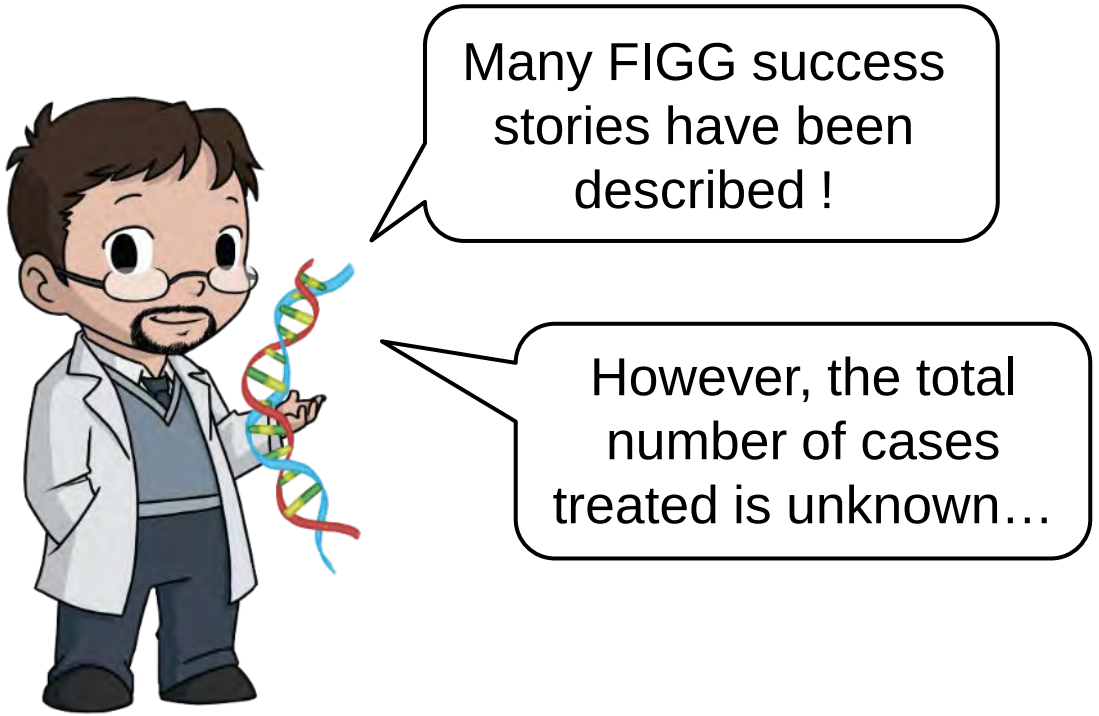


Y Erlich *et al.* Science10.1126/science.aau4832, 2018

Current FIGG Situation

- **FIGG performed** : >1000 in USA, >25 in Canada, some in Australia, Norway, New Zealand, …
- **Pilots/plans to amend the law** : Estonia, UK, the Netherlands, Denmark, Sweden, …
- **Guidelines and standards** : Interim **Policy** on Forensic Genetic Genealogical DNA Analysis and Searching from the United States Department of Justice in 2019. **Working Group** on DNA Analysis Method (SWGDAM), the Investigative Genetic Genealogy **Accreditation Board** (IGGAB), …

https://data.mendeley.com/datasets/82969bsmw4/3


Many FIGG success stories have been described !
However, the total number of cases treated is unknown…

Forensic Science International: Genetics 53 (2021) 102525

Contents lists available at ScienceDirect

Forensic Science International: Genetics

journal homepage: www.elsevier.com/locate/fsigen

Research paper

Getting the conclusive lead with investigative genetic genealogy – A successful case study of a 16 year old double murder in Sweden

Andreas Tillmar, Siri Aili Fagerholm, Jan Staaf, Peter Sjölund, Ricky Ansell

Forensic Science International: Genetics Supplement Series 8 (2022) 336–337

Contents lists available at ScienceDirect

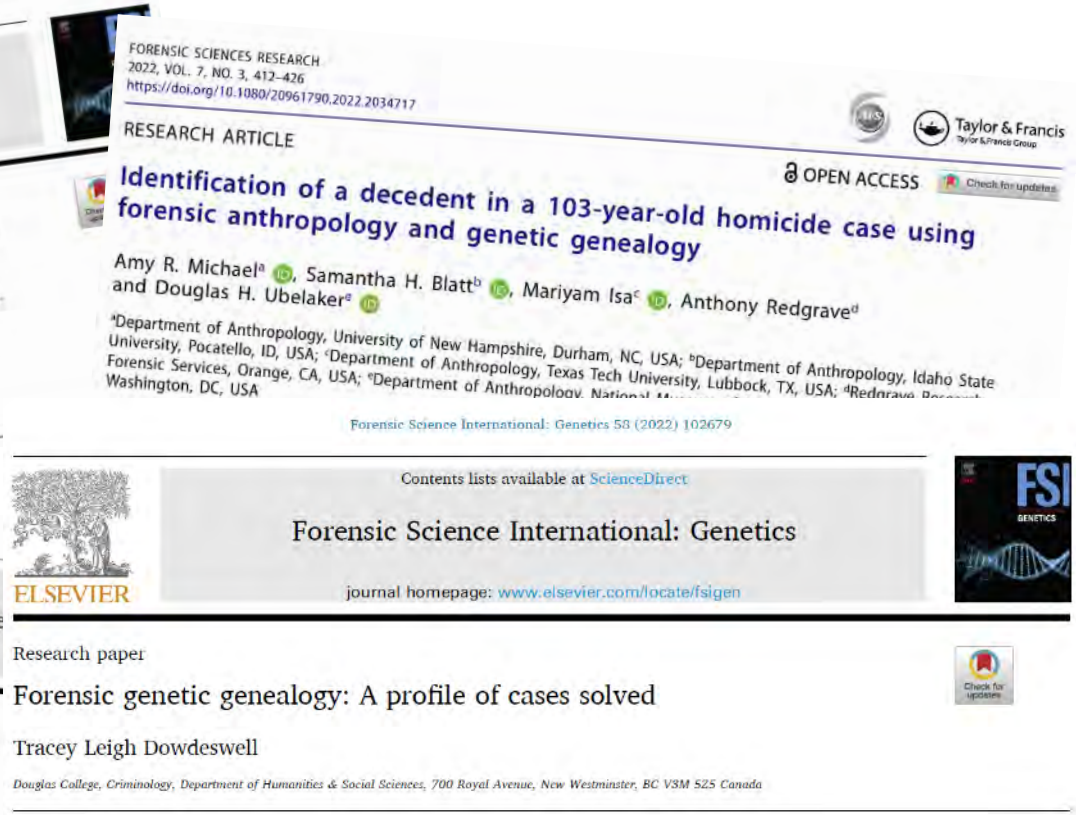
Forensic Science International: Genetics Supplement Se

journal homepage: www.elsevier.com/locate/fsigss

Investigative genetic genealogy for unidentified human remains cases in Oregon

Ellen M. Greytak, Janet Cady, Nici Vance, CeCe Moore, Steven L. Armentrout

30 out of 39 dead persons identified



FORENSIC SCIENCES RESEARCH
2022, VOL. 7, NO. 3, 412–426
https://doi.org/10.1080/20961790.2022.2034717

RESEARCH ARTICLE

OPEN ACCESS

Identification of a decedent in a 103-year-old homicide case using forensic anthropology and genetic genealogy

Amy R. Michael, Samantha H. Blatt, Mariyam Isa, Anthony Redgrave and Douglas H. Ubelaker

Forensic Science International: Genetics 58 (2022) 102679

Contents lists available at ScienceDirect

Forensic Science International: Genetics

journal homepage: www.elsevier.com/locate/fsigen

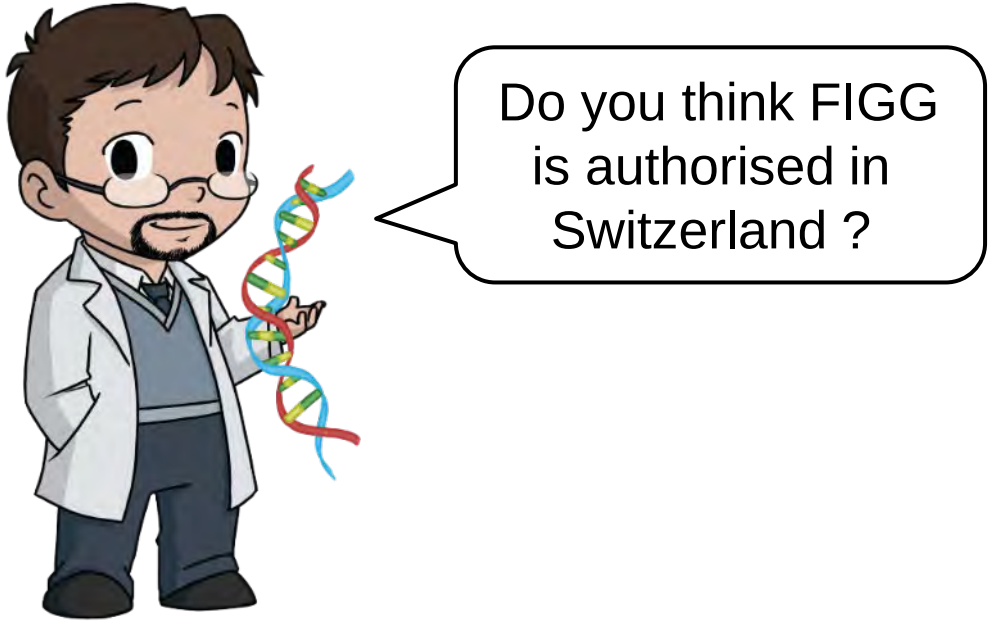
Research paper

Forensic genetic genealogy: A profile of cases solved

Tracey Leigh Dowdeswell

Douglas College, Criminology, Department of Humanities & Social Sciences, 700 Royal Avenue, New Westminster, BC V3M 5Z5 Canada

Review of 436 successful cases


Do you think FIGG is authorised in Switzerland ?

SR363

Federal Act on the Use of DNA Profiles in Criminal Proceedings and for Identifying Unidentified or Missing Persons

(DNA Profiles Act)

of 20.06.03 (Status as of 01.09.23)

Art. 2*a* Familial DNA searching

In order to solve a crime, **a familial search is launched in the information system referred to in art. 10*** with the aim of finding persons who, due to the similarity of their DNA profile to that of the trace donor, could be related to the latter.

* the national DNA database (CODIS)

FIGG is not currently described in the Swiss regulation

FIGG is different from familial DNA searching

1. Familial DNA searching	2. Forensic investigative genetic genealogy
Regulated in CH	Not regulated in CH
Analysis of 16 STRs	Analysis of >10’000 SNPs
Swiss DNA database managed by the Federal Office of Police	Commercial databases with their own regulations
Associations with parent/child and brother/sister	Associations with up to 3rd cousins (and more...)

1. Familial DNA searching

Comparisons with 166'222 suspects and convicted offenders from the national DNA database

Filtering of candidates using additional DNA markers and/or investigation

Current cases

2. Forensic investigative genetic genealogy

Comparison with millions of volunteers (who opted-in)

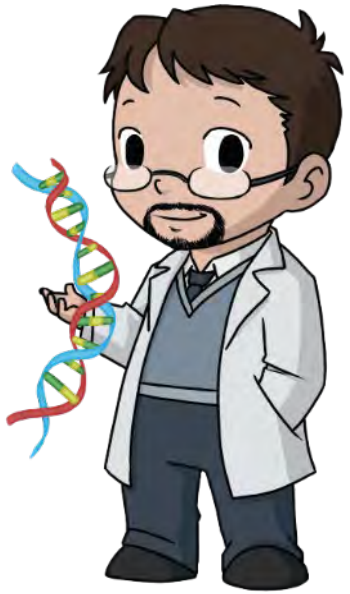
Filtering of candidates using investigation (phenotyping?)

Cold cases


Should we use FIGG in Switzerland ?

A good compromise must be found between **privacy rights** and **public safety**

Forensic investigative genetics is more intrusive than classical forensic genetics. **Regulation is required**



Legal and ethical challenges associated with FIGG

- Conditions for use (what crimes? last resort?)?
- Authorisation for people (and their relatives?) whose DNA is used in criminal investigations?
- Management of “surplus information” *(i.e.,* result of a genetic analysis that is not necessary for its purpose, *e.g.,* medical information)?
- Outsourcing DNA/data analysis to a third country?
- Data breaches/misuse of data from commercial companies?
- Standardisation and transparency in commercial companies?
- FIGG success rate?
- …

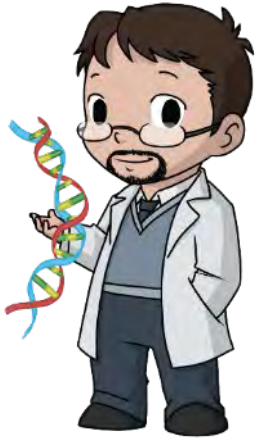
Technical challenges associated with FIGG

- Quantity/quality of the trace DNA (low amount, DNA mixture, degradation, PCR inhibitors)?
- Coverage of the databases (in 2020, 65% of the GEDmatch uploads were from the USA*)? According to the Federal Act on Human Genetic Testing (SR 810.12), in Switzerland, genetic genealogy analyses must be prescribed by health professionals.
- Validation of algorithms, accreditation?
- Impact of errors in genetic data* (and administrative data)?
- …

*D Kling *et al.* Forensic Science International: Genetics 52: 102474, 2021

From the point of view of law enforcement, isn't the risk of error associated with FIGG a problem ?

It is important to distinguish between **classical** and **investigative forensic genetics !**

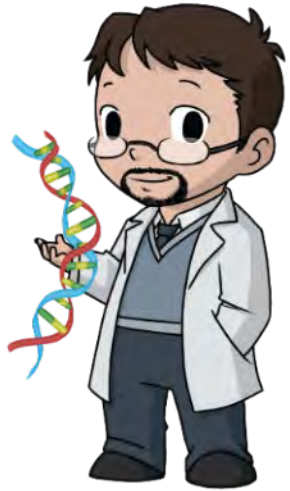


1. Classical forensic genetics	2. Investigative forensic genetics
Results debated in court	Used during investigation
Very low risk of error	Relatively high risk of error
Serious consequence of an error : **miscarriage of justice**	limited consequence of an error : **false lead**
	Candidates can be easily excluded by comparing their DNA profiles with that of the original trace

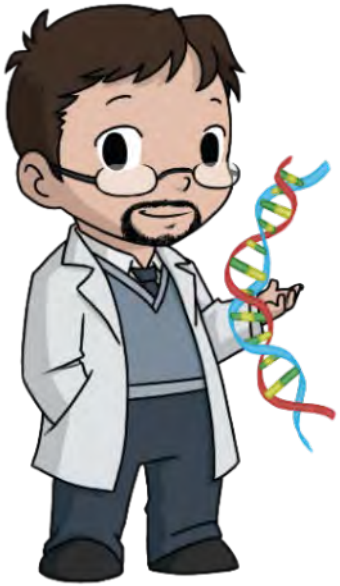
4. Conclusion

FIGG is expanding rapidly in the USA ! Is Switzerland lagging behind ?

The situation is different. In 2023, there was **1 unsolved homicide in Switzerland** (out of 53) compared with **8’504 in the USA** (out of 17’322)

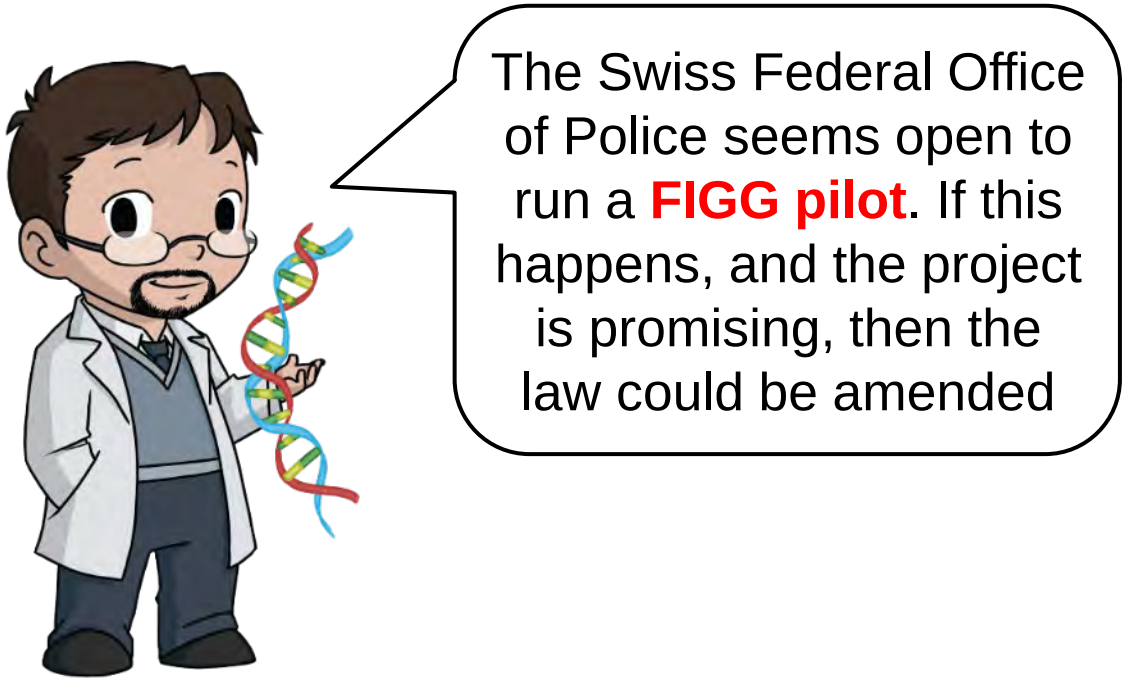


Police crime statistics from the Federal Statistical Office and FBI Crime Data Explorer

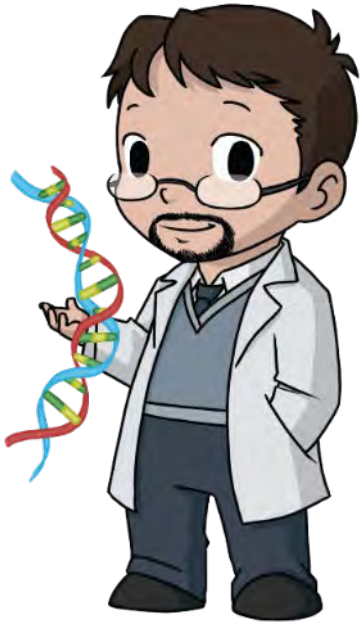


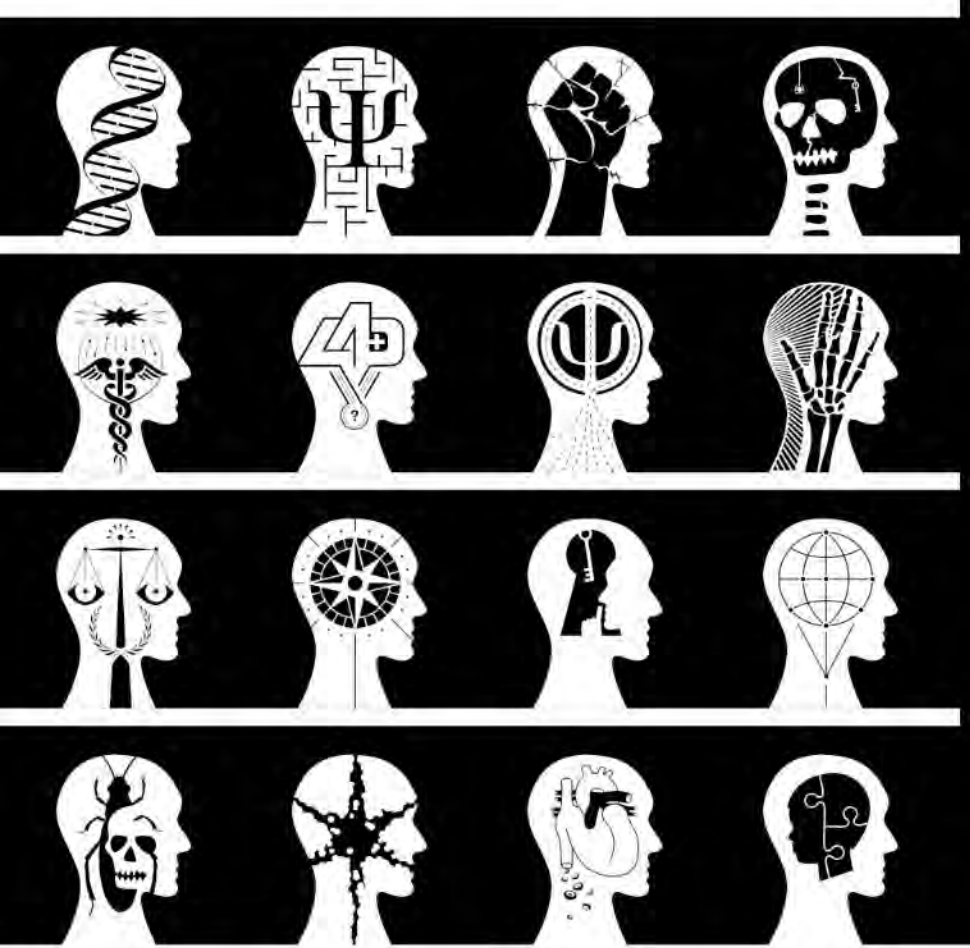
With **specific regulation** and good cooperation between the judicial authorities, genealogists and DNA experts, **FIGG can certainly help to solve some criminal and missing person cases** !

FIGG is invasive and requires a lot of resources. It must be **reserved for particular cases** !


The Swiss Federal Office of Police seems open to run a **FIGG pilot**. If this happens, and the project is promising, then the law could be amended

We must also continue to develop classical forensic genetics as well as other investigation methods and, ideally, **solve cases before they go cold** !





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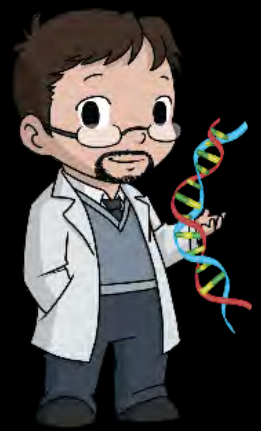

Thank you for your attention !

Questions ?

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