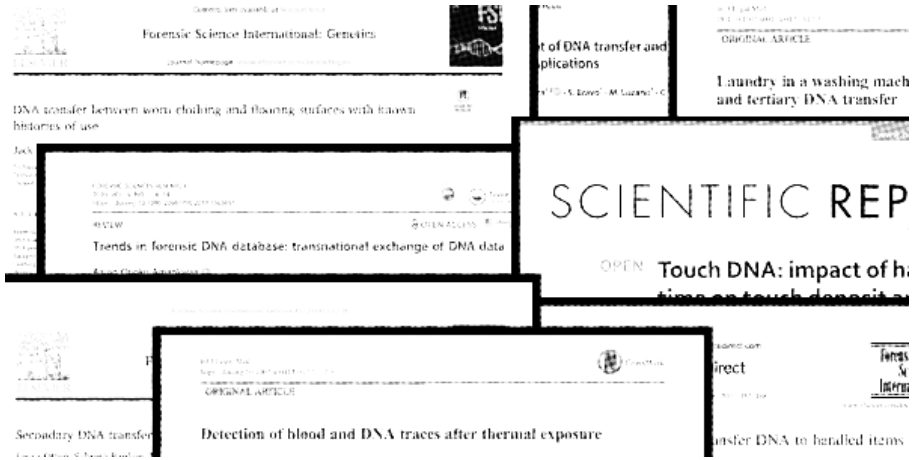
No Trace Project
DNA Literature Review

The present literature review aims to help anarchists and other rebels better understand the ways their adversaries can use DNA to incriminate them. It is not meant as a replacement for existing resources on DNA but rather as a collection of necessary details for those of us who want to delve deeper into the topic.



No Trace Project / No trace, no case. A collection of tools to help anarchists and other rebels **understand** the capabilities of their enemies, **undermine** surveillance efforts, and ultimately **act** without getting caught.

Depending on your context, possession of certain documents may be criminalized or attract unwanted attention. Be careful about what zines you print and where you store them.

No Trace Project DNA Literature Review

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notrace.how/resources/#dna-review

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The present literature review aims to help anarchists and other rebels better understand the ways their adversaries can use DNA to incriminate them. It is not meant as a replacement for existing resources on DNA but rather as a collection of necessary details for those of us who want to delve deeper into the topic. As such, readers of this review are assumed to already have an adequate knowledge of the use of DNA in investigations and the measures that can be taken to protect against this use. Existing resources on DNA can be found on our website.[1]

We have selected and summarized relevant academic articles, and organized the summaries in thematical sections. To fully understand the context of a given summary readers are encouraged to consult the corresponding article, whose reference they will find in the bibliography. We have also included a glossary to clarify the meaning of a few technical terms.

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[2] https://notrace.how/notrace.asc

Contents

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ples were collected through various methods on materials from the devices (e.g. PVC sections, batteries, electrical tape, copper wire). 39 samples (20%) yielded partial DNA profiles while 10 samples (5%) yielded complete profiles.

Glossary

Complete profile: DNA profile that includes the maximum number of genetic markers. See also **Profile**.

Direct transfer: Transfer of a DNA sample from one thing to another through direct contact. For example, if you touch a surface with your finger, thereby transfering skin cells containing your DNA to the surface, it is a direct transfer. See also **Primary transfer**, **Transfer**.

DNA: Acronym of deoxyribonucleic acid. Molecule that contains the genetic code of organisms.

DNA sample: Biological specimen containing DNA molecules. A DNA sample may or may not lead to the obtention of a DNA profile, depending on the quantity of DNA molecules, their level of degradation, and the methods used to obtain the profile.

Full match: Comparison of two DNA profiles where all genetic markers of a profile match the genetic markers of the other. A full match between two complete DNA profiles indicates a very high likelihood that the DNA samples from which the profiles were created were left by the same organism. See also **Match**.

Indirect transfer: Transfer of a DNA sample from one thing to another without direct contact. For example, if you touch a first surface with your finger, thereby transfering skin cells containing your DNA to the surface, and the skin cells are later blown by the wind to a second surface, the transfer of skin cells between your finger and the second surface is an indirect transfer. See also **Secondary transfer**, **Transfer**.

Match: Comparison of two DNA profiles, yielding a likelihood that the DNA samples from which the profiles were created were left by the same organism. See also **Full match**, **Partial match**.

Mixed profile: DNA profile that includes genetic markers from DNA of different organisms. See also **Profile**.

Partial profile: DNA profile that includes less than the maximum number of genetic markers, typically because it comes from a degraded DNA sample. See also **Profile**.

Partial match: Comparison of two DNA profiles where some, but not all, genetic markers of a profile match the genetic markers of the other. See also **Match**.

Primary transfer: Direct DNA transfer. See also **Direct transfer**.

Profile: Set of genetic markers obtained from a DNA sample. The maximum number of genetic markers in a profile depends on the method used to create the profile. Two DNA profiles can be compared to determine the likelihood that the DNA samples from which the profiles were created were left by the same organism. See also **Complete profile**, **Mixed profile**, **Partial profile**.

Secondary transfer: Indirect transfer of a DNA sample with exactly one intermediary. For example, if you touch the exterior of a pair of gloves with your finger, thereby transfering skin cells containing your DNA to the exterior of the pair of gloves, and later your friend puts on the gloves and touches a surface with the gloves, thereby transfering your skin cells to the surface, the transfer of skin cells between your finger and the surface is a secondary transfer, since it is an indirect transfer with exactly one intermediary (the pair of gloves). See also **Indirect transfer**.

Sodium hypochlorite: Chemical compound found in varying concentrations in commercial bleach products. Sodium hypochlorite can be used to degrade DNA samples to prevent their collection and successful analysis.

Touch DNA: DNA sample left by a transfer of biological material (e.g. skin cells, sweat) between an individual's skin and a surface. The transfer can be direct (e.g. touching a door handle with one's bare hand) or indirect (e.g. touching the exterior of a glove with one's bare hand, then touching a door handle with the exterior of the glove).

Transfer: Displacement of a DNA sample from one thing to another. See also **Direct transfer**, **Indirect transfer**.

very high accuracy, and sibling-sibling matches with relatively high accuracy. The study further noted that, although the cost of checking for family matches in a DNA database is minimal, "the cost of following-up the leads generated by family forensic DNA may be extensive, involving interviewing many offenders and then finding and interviewing any of their relatives who could be possible suspects. Sometimes, the computerized search will reveal hundreds of matches at that level. Sometimes, it will reveal only fifty such matches. Sometimes it might reveal a handful—or only one."

A 2019 study[26] highlighted the policy limitations that family forensic DNA encounters in the United States, noting "FBI[7] policy prohibits searches at the national level of [the national DNA database] with the intent of uncovering a familial match; therefore, [Familial DNA Searching] is currently limited to searches of state […] and local [DNA] databases."

Forensic DNA phenotyping

A 2015 study[27] examined forensic DNA phenotyping (FDP), the prediction of human appearance from DNA samples. FDP may provide leads in investigations where DNA samples have been recovered but no suspects have been identified. The study showed that eye color, hair color, and skin color can be predicted with relatively high accuracy (approximately between 70% and 95% depending on many factors), and that research is ongoing to attempt to predict other characteristics, including body height, baldness, and age.

Statistics

A 2015 study[28] examined the recovery of DNA profiles in 56 real cases involving explosive devices in Thailand. 195 DNA sam-

[7] *N.T.P. note:* The Federal Bureau of Investigation (FBI) is the primary federal law enforcement agency in the United States.

International cooperation

A 2020 study[23] examined the transnational exchange of DNA data. The study identified three approaches to this exchange:

- International DNA databases, such as the Interpol DNA database (holding more than 280 000 profiles contributed by 87 countries as of 2025[24]) or the Europol Information System.
- Linked or networked national DNA databases. For example, in the European Union, since 2008 the Prüm Convention requires all member states to maintain a DNA database that can be accessed by other member countries.
- Request-based exchange of DNA data. This type of exchange is practiced by many countries across the world, can include automated searching of the database of a country by another country, and is often limited to serious crimes.

Family forensic DNA

A 2006 study from the United Kingdom[25] explained that "DNA runs in families. Two people who are closely related genetically are likely to share more alleles than two people who are not closely related. The patterns of these similarities depend, however, on the type of familial relationship." The study explained that forensic DNA may provide leads in investigations, and that for example, if a DNA profile has been extracted from a DNA sample found at a crime scene, and this DNA profile does not match any profile in the country's DNA database, the profile may nonetheless partially match database profiles belonging to close relatives of the person who left the sample found at the crime scene, which can lead investigators to this person. The study showed that family forensic DNA can be used to establish parent-child matches with

contributor ratios. For example, a DNA sample containing a very large amount of DNA from a person A and very small amounts of DNA from ten other people can lead to the obtention of a complete DNA profile of person A.

Transfer

Direct transfer (body to surface)

A 2007 study[1] examined the direct transfer of DNA by asking volunteers to hold sterile (i.e. DNA-free) tubes in their bare hands for 10 seconds shortly after having washed their hands. In an experiment, 60 volunteers were asked to wash their hands, then carry on with their normal activities (without eating or touching other people) for 15 minutes, and then hold a sterile tube with their dominant hand for 10 seconds. A DNA sample was then collected from the tube with swabs and analyzed. Each volunteer repeated the experiment with their non-dominant hand, resulting in a total of 120 samples. Out of the 120 samples, 8 samples (7%) provided complete DNA profiles of the volunteers and 39 samples (32%) provided partial profiles.

A 2019 study[2] examined the direct transfer of DNA by asking 10 male volunteers to hold specific areas of bras (that had previously been worn by female volunteers for one day) between their fingers (thumb and index) for durations ranging from 2 seconds to 60 seconds. DNA samples were then collected from the specific areas held by the male volunteers. Complete DNA profiles of the male volunteers were found in the vast majority of samples: between 88% and 99% of samples depending on the holding duration. The study explained that these high percentages were due to the collection of DNA from the specific areas held by the male volunteers, which is often not possible in real forensic cases where the specific areas of items of clothing that have been touched by suspects are often unknown.

A 2022 study[3] highlighted the many factors that can influence the amount of DNA that one leaves when touching a surface with their skin, including age, sex, certain activities (wearing gloves, rubbing fingers on body parts), hand washing, and sweating. The study also noted that the amount of DNA left is influenced by

which body part comes into contact with the surface, noting "body location impact results too, for example, sebaceous skin areas (vs. non-sebaceous), the dominant hand (vs. non-dominant), and fingertips (vs. palms) potentially facilitate DNA deposits."

Indirect transfer through clothing (body to clothing to surface)

With contact between clothing and surface

A 2018 study[4] examined the transfer of DNA between items of clothing washed together in a washing machine. In an experiment, new, unworn socks were washed together with "typical laundry content of four different households," at temperatures ranging from 30°C to 45°C. DNA samples were collected from the socks afterwards. Out of 32 samples, 6 samples (19%) matched a member of one of the households.

A 2019 study[5] examined the secondary transfer of DNA through work gloves. In an experiment repeated several times, a person P1 simulated a house move using a pair of work gloves: they put on the gloves, assembled and moved a box, took off the gloves, put them back on, moved the box again, and finally took off the gloves. Then, a person P2 simulated a robbery using the same pair of gloves used by P1: they put on the gloves, screwed a screw in a piece of wood using a screwdriver, took off the gloves, put them back on, unscrewed the screw using the same screwdriver, and finally took off the gloves. Both P1 and P2 put on and took off the gloves in a standard way, thereby touching the exterior of the gloves with their hands. The gloves were 100% nylon with an additional latex coat on the palms and fingers. The study found that, in 6 cases out of 19 (31%) DNA traces collected from the screwdriver matched the DNA of P1, meaning that the DNA of P1 was transfered from their hands to the gloves during the house move simulation, then from the gloves to the screwdriver during the robbery simulation.

Analysis

Touch DNA

The 2017 guidelines of the forensics department of a U.S. police agency[21] noted that touch DNA samples are often likely to have only been touched for a limited time by a suspect, or to have been touched by several people, leading to "limited (or no definitive) conclusions regarding inclusion or exclusion of a particular person of interest."

Mixed profiles

A 2022 study[22] examined the ability of forensic laboratories to interpret mixed DNA profiles. The study explained that it is relatively easy to interpret a profile obtained from a DNA sample containing DNA from one person (as long as there is enough DNA and it isn't too degraded), but that it is more difficult when the DNA sample contains DNA from several people. In an experiment, several forensic laboratories were asked to interpret four mixed DNA profiles obtained from samples containing DNA from two people (with contributor ratios[5] of 3:1, 2:1, 3.5:1, and 4:1 respectively), and two mixed DNA profiles obtained from samples containing DNA from three people (with contributor ratios of 4:1:1 and 1:1:1 respectively). Based on this experiment, the study concluded that mixed profiles originating from two people are generally interpretable (as long as there is enough DNA and it isn't too degraded), while mixed profiles originating from three people cannot be interpreted by most forensic laboratories, although a few do manage to interpret them.[6]

[5] *N.T.P. note:* The contributor ratio is the relative amount of DNA each person contributed to the sample.

[6] *N.T.P. note:* Note that this conclusion is based on the contributor ratios used in the experiment, and would not be valid for highly disproportionate

Soot removal

A 2020 study[19] described how, in arson investigations, different techniques can be used to remove soot that has accumulated on surfaces during the fire to reveal DNA samples hidden beneath the soot. The study further noted that: "Some techniques are very costly and time consuming and therefore not appropriate for the scene to be treated in its entirety. Often areas and objects of interest will need to be selected for treatment."

Luminol

A 2012 study[20] examined the use of luminol to locate blood samples at crime scenes that are invisible to the naked eye. Luminol is a chemical that exhibits chemiluminescence, with a blue glow, when it reacts with the iron in hemoglobin, a protein contained in blood. At a crime scene suspected to contain blood, investigators can therefore use luminol on surfaces suspected to contain blood, and if the luminol glows they can collect DNA from where it glows.

Statistics

According to a 2020 study[9] referencing a 2014 statement, "the current DNA technical leader at the Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF)[4] laboratory stated that over 90% of their evidence samples were from 'touch evidence' found on guns, bomb components, and Molotov cocktails."

[4] *N.T.P. note:* A United States law enforcement agency investigating firearms and explosives, acts of arson and bombings, and illegal trafficking and tax evasion of alcohol and tobacco products.

A 2022 study[6] examined the indirect transfer of DNA between worn clothing and floor surfaces. In an experiment, 12 volunteers were provided with a set of new and unused clothing items (a long sleeved t-shirt and trousers). Each volunteer wore the items for ~8 hours inside their own home, and later moved (either on foot or in a vehicle) to a second, unrelated home (there was one second home for each volunteer, so 12 in total). In the second home, the volunteer "sat on the floor, laid on their back with their legs straight and arms at their side, before rolling from their back to their left side and onto their back again, and then standing up" (the total duration of this activity was ~30 seconds). During this activity the volunteer wore a face mask and was instructed not to speak or touch with their hands the area of the floor where they performed the activity, in order to avoid the transfer of DNA not originating from the clothing. Across all 12 volunteers, 60 samples were collected from areas of the floors with which the items of clothing were in contact during the activity. The DNA of the volunteers were detected in 8 out of 60 samples (13%).

Without contact between clothing and surface

A 2021 study[7] examined the indirect transfer of DNA from used clothing to a surface by shaking the clothing over the surface. In an experiment, 10 volunteers each provided an item of clothing that they had worn as the first layer of clothing (i.e. next to the skin) on the upper half of the body (excluding bras and similar items). Before providing the item, the volunteers were requested to wear it for either a minimum of ~8 hours performing general activities or low-level exercise or a minimum of ~1 hour performing moderate to vigorous-level exercise, without washing the item. The items were then each gently shaken three times 35–40 cm above a large glass sheet, before being held still for 5 seconds above this same sheet. Finally, DNA samples were collected from the glass sheet for each item. The DNA of the volunteer who provided the item was detected in the sample in 9 out of 10 cases (90%).

Degradation

High temperatures (prolonged exposure)

In ovens

A 2019 study[8] examined the recovery of DNA profiles from DNA left on various surfaces through brief skin contact after heating the surfaces at high temperatures. Several volunteers left DNA on paper, glass, and metal surfaces by touching the surfaces with their fingers for 10 seconds. The surfaces were then heated at temperatures ranging from 50°C to 300°C. The study found that complete DNA profiles could be recovered after heating at 50°C and 90°C, partial profiles at 110°C and 150°C, but no profiles at 200°C and 300°C (the heating duration is not specified in the study).

A 2020 study[9] examined the recovery of DNA profiles from blood and saliva stains after exposure to high temperatures for 30 minutes. The study found that complete profiles could be recovered after heating at 140°C, partial profiles at 180°C, but no profiles at 200°C.

A 2025 study[10] examined the recovery of DNA profiles from blood stains after exposure to high temperatures for various durations. The study found that heating at 150°C for less than 10 minutes had minimal effect on the recovery of DNA profiles, that partial profiles could be recovered after heating at 150°C for 20 minutes or at 180°C for 5 minutes, and that no profiles could be recovered after heating at 180°C for 20 minutes or 200°C for 10 minutes.

In real fires

A 2009 study[11] examined the recovery of DNA profiles from blood stains in a four-room structure built and set on fire for

Collection

General procedure

According to a 2020 study,[9] if the item that is suspected to carry DNA can be moved, it can be removed from the crime scene to allow for the collection of DNA in the laboratory. Otherwise, DNA can be collected at the crime scene. DNA is typically collected using swabs, either applied to visible biological marks (e.g. blood, saliva) or to surfaces suspected to carry DNA (e.g. door handles). DNA can also be collected using tape or wet vacuums.

Touch DNA

A 2011 study[18] outlined a recommended protocol for crime scene investigators for the collection of touch DNA at crime scenes. This protocol included:

- Wearing as much Personal Protective Equipment (PPE) as possible: gloves, face masks, hair nets, and even whole body suits, to avoid contamination via exposed skin, shed hairs, sweat, or saliva.
- Avoid speaking over evidence items, even if wearing a face mask.
- Collect items using disposable forceps rather than gloved hands.

A 2019 study,[2] discussing the necessity to target an area of interest when collecting touch DNA on clothing, explained that "touch DNA on clothing is normally not visible even under a forensic polilight source."

According to a 2020 study,[9] touch DNA is collected and analyzed under the assumption that it is present on a surface that was probably touched by a person of interest (e.g. a door handle), and fingerprints can indicate the presence of touch DNA.

Washing machines

A 2025 study[17] examined the degradation of DNA on fabric after washing in a washing machine. In two experiments, pieces of cotton fabric with DNA were washed in a washing machine at 40°C, at 1000 rpm (revolutions per minute), with detergent, for 57 minutes:

- In the first experiment, several volunteers left DNA on pieces of cotton fabric by rubbing and squeezing the pieces for 30 seconds, without having washed their hands beforehand. After washing, only partial profiles could be recovered, with the researchers noting that "it is not possible to identify the [individuals] after washing in the washing machine."
- In the second experiment, several volunteers left DNA on pieces of cotton fabric by letting a few drops of their blood fall on the pieces of fabric. After washing, complete profiles could be recovered in 11.1% of cases (3 volunteers out of 27), and partial profiles in some other cases, with the researchers noting that "the experiments carried out allow us to confirm the recovery of partial profiles in cotton fabrics with small volumes of blood after washing in a washing machine."

Explosions

A 2020 study[9] showed that partial and complete DNA profiles can be recovered from explosive devices that have exploded, with varying degrees of success depending on the type of sample (e.g. saliva, touch DNA) and the type of explosive used in the device.

the study. The four-room structure, meant to simulate a small apartment, measured 9m by 4.5m and was 2.5m high. Each room contained furniture and objects typically found in an apartment. Many blood stains were placed on various surfaces inside the rooms. A sofa in one of the rooms was set on fire by applying direct flames to it for 300 seconds using a gas burner. The fire was then allowed to develop naturally for approximately 45 minutes before being put out by firefighters using water. Temperatures measurements were made at various points of the rooms during the fire, providing the maximum temperature reached at each of those points. The study found that:

- The following four blood stains that were close to the sofa did not provide DNA profiles:
  - A stain on a wall next to the sofa that reached 904°C.
  - A stain on the ceiling above the sofa that reached 861°C.
  - A stain on a wall approximately 1.5m in front of the sofa that reached 848°C.
  - A stain on a coffee table close to the sofa that reached 328°C.
- Most of the other blood stains reached less than 297°C, and most of them provided complete DNA profiles.

The study concluded: "In general, samples from structure fires recovered for DNA analysis will have a greater likelihood of yielding a full DNA profile the farther they are from the fuel source and, essentially, the closer they are to the floor."

High temperatures (brief exposure)

A 2018 study[12] examined the recovery of DNA profiles from blood stains after exposure to high temperatures in a flashover

[3] *No Trace Project (N.T.P.) note:* When a fire occurring inside a room reaches a high enough temperature—typically between 500°C and 600°C—it reaches *flashover*, a brief period during which the room is so hot that all ignitable surfaces ignite more or less simultaneously and the fire spreads rapidly

simulator.[3] The study found that complete DNA profiles could be recovered after exposing the stains to 1000°C.

Sodium hypochlorite

A 2015 study[13] examined the destruction of DNA by spraying DNA samples with a sodium hypochlorite solution and wiping the sprayed surface. In an experiment, samples of blood, semen, and touch DNA were positioned on different types of surfaces: pitted plastic, smooth plastic, and steel (each sample type was tested with each surface type). A 1% sodium hypochlorite solution was then sprayed thoroughly on the samples, left for 5 minutes, and wiped dry. DNA collection and analysis was then performed on the samples. The study showed that DNA was effectively undetectable for almost all combinations of sample and surface types, except for pitted plastic where small quantities of DNA could be detected.

A 2020 study[14] examined the destruction of DNA by immerging DNA samples in a sodium hypochlorite solution. In an experiment, blood samples were immerged for 1 hour in a 6% sodium hypochlorite solution. The study showed that DNA was still detectable in large quantities after the immersion. The study further noted that efficacy of the protocols typically used to remove DNA from surfaces in forensic laboratories, which typically employ a sodium hypochlorite solution followed by wiping the surface, "may actually be partially due to physical removal of DNA from a surface ('wiping away') as opposed to chemical destruction or damage."

A 2022 study[15] examined the destruction of DNA by spraying DNA samples with a sodium hypochlorite solution and wiping the sprayed surface. In an experiment, blood samples were positioned on plastic, metal, and wood surfaces. In each case, a 0.4% sodium hypochlorite solution was then sprayed on the surface,

throughout the room. A flashover simulator simulates this phenomenon, exposing materials to high temperatures for short durations.

and the surface was wiped in three circular movements and left to dry for 2 hours. The amount of DNA still present on the surface after the treatment was then measured. The study showed that the treatment removed, on average, 94% of DNA on plastic surfaces, 87% on metal surfaces, and 97% on wood surfaces.

Water

A 2018 study[16] examined the recovery of DNA profiles from blood stains and skin cells on pieces of fabric after immersion of the pieces in water. In an experiment, five volunteers left skin cells on 7x6 cm pieces of cotton fabric by rubbing the pieces over their neck for ~5 seconds with medium pressure. In addition, three volunteers left blood stains on similar pieces of fabric. The pieces of fabric were then immersed in water in different scenarios, and, after different durations, DNA collection and analysis was performed on the pieces of fabric. The study found that:

- Complete DNA profiles (CP) could be recovered from the pieces of fabric with skin cells after:
  - 10 minutes under running tap water, whether cold or warm
  - 1 hour in a river in summer (but no CP after 4 hours)
  - 3.5 hours in a pond in summer (but no CP after 4 hours)
  - 6 hours in a river in winter (but no CP after 23 hours)
  - 1 week in a bathtub, whether with or without soap (but no CP after 2.5 weeks)
  - 2 weeks in a pond in winter
- Complete DNA profiles could be recovered from the pieces of fabric with blood samples after:
  - 1 day in a pond in summer (but no CP after 1 week)
  - 1 day in a river in summer (but no CP after 1 week)
  - 3 days in a river in winter (but no CP after 5 days)
  - 5 days in a pond in winter (but no CP after 1 week)