A Review of Recently Published Fingerprint Research (2014-2015)

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Introduction

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An investigation into the detection of latent marks on the feathers and eggs of birds of prey

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ABSTRACT

There are numerous enhancement techniques (physical and chemical) which have been developed for the successful visualisation of latent fingermarks. Nonetheless, problems arise when latent fingermarks require enhancement on difficult surfaces such as human skin, food stuffs, fabric and animals. The ability to develop latent fingermarks on the surface of bird of prey feathers and that of their eggs was investigated. Red and green magnetic fluorescent powders proved to be most suitable on the surface of bird of prey feathers whereas black magnetic powder was the most suitable technique on the eggs. These powders produced the highest quality of visible ridge-detailed developments over a controlled period of time.

1. Introduction

The Royal Society for the Protection of Birds (RSPB) reports that since 1989, in Scotland alone, there have been over 500 birds of prey killed by illegal poisoning with a further 340 confirmed as shot, trapped or with their nests destroyed [1]. Wildlife crime may be defined as, "the buying, selling, harming or disturbing of wild animals or plants that are protected by law," and at the beginning of 2012 the poisoning, trapping and illegal shooting of protected wildlife were thought to be more widespread than it has ever been in the past 50 years [2]. In the same year and region, there were 25 reported incidents of egg collecting and egg thefts, and seven reports of eggs being sold [1]. Illegal egg collection is now a well-equipped activity with the nest disturbers being in possession of all the necessary outdoor clothing and climbing gear needed to reach the more highly sought after eggs.

Fingermarks may be recovered from numerous crime scenes and can still provide a categorical conclusion rather than one based on probability for evidence such as DNA or fibre analysis and are now being researched as the main method by which this vital wildlife crime to suspect link can be forged [3]. Additionally, the Home Office Centre for Applied Science and Technology (CAST) reports that despite some public perceptions that fingermarks have mostly been superseded by DNA, fingermarks still account for appreciably more identifications overall and show no sign of being phased from use [4]. The surface onto which a fingermark has been deposited will ultimately determine the enhancement technique selected to develop that mark, in particular its porosity; however the condition and/or composition of the latent fingermark itself and the level of contamination present within the deposition, if any, are also contributing factors. Recent research endeavours in latent mark detection on difficult surfaces include human skins [5–7], food stuffs [8–10], fabric [11] and animals [12–14]. Cyanoacrylate fuming and powdering techniques have been reported as potential enhancement techniques for deer antlers, elephant tusks and live reptiles [12–14].

With the killing of wild animals equating to big business for poachers, wildlife DNA analysis is currently popular for the characterisation of different species [15–17]; however the use of fingermark enhancement in the investigation of wildlife crime appears to be limited. The microscopic weave structure of a feather has been likened to that of fine weave fabrics such as nylon, upon which it is may be possible to develop grab marks using vacuum metal deposition and touch DNA profiling. The main aim of this study was to investigate a range of latent fingermark development techniques for the development of latent fingermarks on specific bird of prey feathers and eggs.

2. Materials and methods

2.1. Sample preparation

A total of six species of bird of prey feathers (kestrel, sparrowhawk, buzzard, red kite, golden eagle and white-tailed eagle) and seven species of bird of prey eggs (kestrel, sparrowhawk, golden eagle, goshawk, tawny owl, barn owl and long-eared owl) were examined (Fig. 1). The

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- McMorris H, Farrugia K, Gentles D. An Investigation into the Detection of Latent Marks on the Feathers and Eggs of Birds of Prey. *Sci & Just* 2015; 55:90-96.
- The goal of this work was to develop latent prints on a variety of exotic bird eggs and feathers (of different sizes and weave densities).
- Bird feathers included: kestrel, sparrowhawk, buzzard, red kite, golden eagle, and white-tailed eagle.
- Bird eggs included: kestrel, sparrowhawk, golden eagle, goshawk, tawny owl, barn owl, and long-eared owl.

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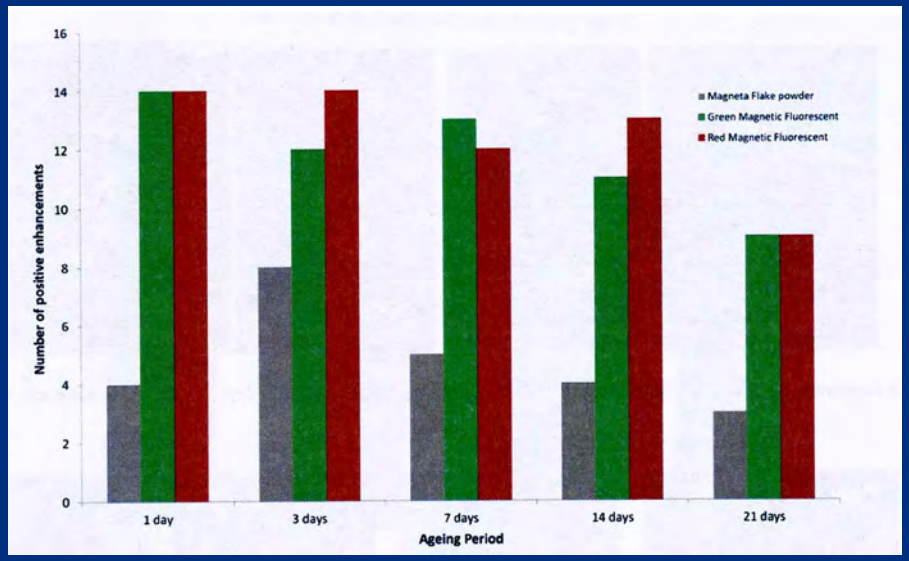
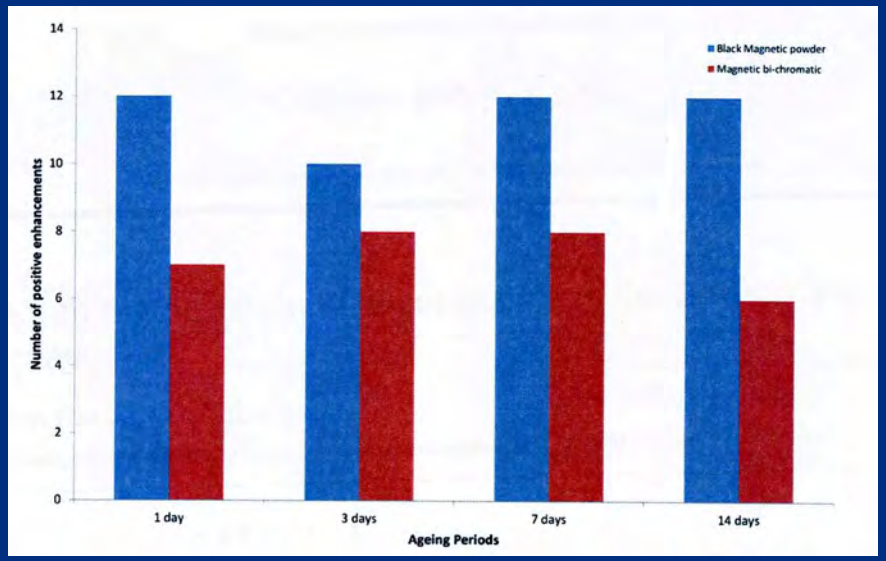
Results

- Magnetic fluorescent powders had good success developing ridge detail on feathers (though most development graded 1-2 out of 4).
- The least effective methods on feathers were white magnetic and aluminum powders.
- Dramatic decrease in development over the course of 21 days.
- The finer the weave of the feather the better quality of print.
- Black magnetic powder was most effective on bird eggs (100% success rate at 1 day, 7 days, and 14 days after deposition).
- The least effective method on bird eggs was aluminum powder.

Results





Number of positive marks developed on bird feathers.

	Magneta flake	Red magnetic fluorescent	Green magnetic fluorescent
Grade 0	26	8	11
Grade 1	10	50	41
Grade 2	12	10	11
Grade 3	2	2	6
Grade 4	0	0	1
Total	**50**	**70**	**70**
Percentage of positive marks (%)	48	89	84

Number of positive marks developed on bird eggs.

	Black magnetic	Magnetic bi-chromatic	Magneta flake powder	Green magnetic fluorescent
Grade 0	*2*	*7*	*2*	*2*
Grade 1	*6*	*9*	*1*	*1*
Grade 2	*8*	*13*	*2*	*1*
Grade 3	*16*	*5*	*0*	*3*
Grade 4	*16*	*2*	*0*	*2*
Total	***48***	***36***	***5***	***9***
Percentage of positive marks (%)	*96*	*81*	*60*	*78*

Introduction

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Fingermark recovery from riot debris: Bricks and stones

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ABSTRACT

During the UK riots in August 2011, large volumes of bricks and stones were used as weapons or projectiles in acts of violence or to gain illegal entry to properties. As a result, it has been emphasised that it is necessary to determine suitable chemical treatment(s) that will enable the development of fingermarks on such items in order to identify those involved. This study has undertaken the task of attempting to develop latent fingermarks on common house bricks, limestone and sandstone using current techniques including ninhydrin and fluorescence. Results produced have shown that, with fluorescent fingerprint powder, silver nitrate and superglue providing the best results, it is now possible to enhance fingermarks that were previously left undeveloped. In addition, Isomark T-1 Rapid Grey High Resolution Forensic Impression Material has proved extremely effective as an alternative method of recovering fingermarks developed with fluorescent fingerprint powder.

1. Introduction

Fingermark evidence has been well established in the criminal justice system for over a century. However, with the raised profile of forensic techniques among the population, and the heightened awareness of criminals, it has become necessary to investigate new, less known opportunities for acquiring evidence [1]. One such opportunity is in the recovery of fingermarks from difficult surfaces, such as bricks and stones.

Bricks and stones are common artefacts in non-violent crimes such as burglary and theft from motor vehicles, as they are widely available and are ideal items for breaking glass to gain entry. The artefacts are also used in violent crimes, commonly as projectile weapons, most notably in the pursuit of attacking emergency services. This type of violence in the UK peaked in the civil unrest in August 2011, with rioting breaking out in cities across the country, and attacks on emergency services remain commonplace [2].

Despite their wide use in criminal activities, it has long been the accepted view of law enforcement agencies that these surfaces are unsuitable for fingermark recovery. However, preliminary studies have shown that this may not be the case and that, under certain circumstances, fingermark recovery may be possible [3–5].

The aim of this study was to find appropriate treatment(s) for the enhancement of latent fingermarks on a range of brick and stone surfaces. This was undertaken in three objectives:

- To find suitable chemical treatment(s) for the surfaces of bricks and stones;
- To explore the suitability of using effective chemical treatments(s) in sequence; and
- To find the chemical treatment(s) that produces optimum results in the enhancement of latent fingermarks on bricks and stones.

2. Materials and methods

2.1. Materials

A total of ten participants donated fingermarks for the purpose of development in the study. The participants consisted of two males and eight females, aged between 18 and 40 years of age, who varied in donor strength. The participants were predominantly White British, and included smokers, vegetarians, and those who took regular medication. All participants signed consent forms and were assigned a Donor Identification Number to provide anonymity.

A single type of brick was tested, common house brick, retrieved from a domestic garden in North Yorkshire. In addition, sandstone and limestone were also tested and were obtained from a local B&Q store in the form of paving stones.

Each experiment was repeated a minimum of three times.

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- Davis L, Fisher R. Fingermark Recovery from Riot Debris: Bricks and Stones. *Sci & Just* 2015;55:97-102.
- The goal of this project was to determine the best technique or sequence of techniques for developing latent prints on bricks and common stones (within 24 hrs. of deposition).
- Investigate the common perception that these types of surfaces are unsuitable for developing latent prints.
- Substrates included red brick, sandstone, and limestone.

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Results

- Processes included: GREENescent™, PINKescent™, and REDescent™ powders; ninhydrin; silver nitrate; CA fuming.
- Sequencing: CA + ninhydrin + silver nitrate; CA + magnetic powder.
- Results (1): GREENescent™ powder was the best overall; powder and CA fuming (limestone); silver nitrate (brick > sandstone); sequential treatments were ineffective (and were destructive to existing detail).
- Results (2): Isomark™ was the best recovery medium (although air bubbles were problematic at times); tapes lifted accumulated powder on raised textured surfaces (causing contrast problems).

Results

Average results for treatments used individually on each surface.

	Brick					Limestone					Sandstone				
	Grade of marks achieved			Rate of success (%)	Average successful grade	Grade of marks achieved			Rate of success (%)	Average successful grade	Grade of marks achieved			Rate of success (%)	Average successful grade
	0	1–2	3–4			0	1–2	3–4			0	1–2	3–4		
Fluorescence	30	0	0	–	–	47	0	0	–	–	47	0	0	–	–
Fluorescent powder	60	0	0	–	–	12	4	7	47.8	2.8	23	0	0	–	–
Ninhydrin	31	2	0	–	–	29	4	0	12.1	1.3	32	1	0	–	–
Silver Nitrate (hydrophobic)	25	3	1	13.8	2.5	29	0	0	–	–	28	0	1	–	–
Silver nitrate (porous)	12	2	0	–	–	14	0	0	–	–	13	1	0	–	–
Superglue	32	3	0	8.6	1.7	25	9	1	28.6	2	30	5	0	14.3	1

Average results of lifting attempts.

Medium	Treatment	Result
Eezie Tabs	Fluorescent powder [a]	0
Isomark™	Fluorescent powder [a]	3.2
	Silver nitrate [b]	0
	Superglue [a]	0
J-Lar	Fluorescent powder [a]	0

[a] From limestone.
[b] From brick and sandstone.

Introduction

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Comparison of practical techniques to develop latent fingermarks on fired and unfired cartridge cases

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ABSTRACT

We have tested some widely used and practical fingermark enhancement techniques such as powdering (regular powder dusting and magnetic powder application), cyanoacrylate fuming, fluorescent dying (basic yellow 40), gun blueing solutions and acidified hydrogen peroxide solutions. The results were evaluated and compared in order to establish best procedures on processing cartridge cases. The tests were performed on brass discs subjected to three different temperatures (room temperature, 63 and 200 °C), and on fired and unfired cartridge cases. All the samples were processed after three different periods of time (24 h, 7 days and 14 days) after deposition. The best results for both fired and unfired cartridge cases were obtained by the sequential application of cyanoacrylate, gun blueing solution and basic yellow 40. Some stages of the firing process were isolated in order to identify their effects over the final amount and quality of the remaining latent fingermarks on cartridge cases. Good state fingermarks were developed on unfired cartridge cases cycled through the gun, showing that friction inside the gun without firing does not cause significant damage to the fingermarks. On the other hand, fired cartridge cases are significantly affected by the firing effects, exhibiting low quality ridge details which are mainly located next to base. An unexpected phenomenon was observed on most of the brass discs heated to 200 °C and developed with gun blueing solutions; they presented a reverse development compared to the expected one, with darkening of the ridges instead of the background.

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1. Introduction

The fingermark recovery on fired cartridge cases is a challenge. There are discussions about the best methods to be used and a small proportion of cases with positive identification of suspects are reported [1–5]. Some important fingermark enhancement techniques are cyanoacrylate fuming (CA) [3–11], regular powder dusting (RP) and magnetic powder application (MP) [2,5,6,8,12], fluorescent dying [3,4,6–8,11] such as basic yellow 40 (BY40), gun blueing mixtures (GB) [6,7,9–11], acidified hydrogen peroxide (AHP) [8,9], vacuum metal deposition [6,13,14], palladium salts [7,10], electrolysis [6,15,16], electrostatic deposition [1,10,17] and scanning Kelvin probe [18–20]. Some of these techniques and developers are expensive and require technical refinements that are not available for routine forensic applications, such as mentioned by Williams [19] for the use of scanning Kelvin probe. The use of CA as a primary enhancement technique is required for the application of some techniques such as fluorescent dying with BY40, and is recommended for others such as powdering and GB.

The aim of this study was to gather and evaluate under the same conditions some widely used and available fingermark enhancement techniques to recovery latent fingermarks from fired and unfired cartridge cases. The results can be used in order to optimize procedures for latent fingermark experts when processing this kind of evidence. A number of experiments were performed on different substrates under various conditions, aiming at isolating some stages of the firing process to determine their influence on the quantity and quality of the remaining latent fingermarks in fired cartridge cases.

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- Girelli CMA, Lobo BJM, Cunha AG, Freitas JCC, Emmerich FG. Comparison of Practical Techniques to Develop Latent Fingermarks on Fired and Unfired Cartridge Cases. *Forensic Sci Int* 2015;250:17-26.
- The goal of this work was to determine the best method or sequence of methods to develop prints on fired and unfired casings.
- Development methods included: CA fuming + regular or magnetic powders; CA + gun blue; CA + BY40; gun blue; and several acidified hydrogen peroxide formulations.

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Results

- 9 mm brass ammunition used for fired/unfired experiments aged for 1, 7, and 14 days prior to development.
- Tests on unfired ammunition indicated that friction processes (cycling in the weapon without firing) are not degrading prints significantly.
- On fired casings, no print graded higher than 2 (out of 4) was recorded.
- Overall the best sequence for fired/unfired cartridge cases was CA + gun blue + BY40 (in agreement with previous studies).
- Most ridge detail developed was found near the base of the casing.
- The use of brass discs to simulate brass ammunition in testing was not realistic or successful (results were completely different).

Results

- Three possible explanations for loss of ridge detail on fired ammunition: (1) blowback of hot propellant gases; (2) expansion of cartridge due to heat/pressure; (3) influence of propellant byproducts.

Statistics with the average number of fired cartridge cases (for sets of 20 samples) with grades 0, 1A and 1B evaluated by two independent experts following the slightly modified Bandey's grading scale (cf. Section 2.5) for each period of elapsed time after firing.

Technique	24 h			7 days			14 days		
	0	1A	1B	0	1A	1B	0	1A	1B
CA + RP	18.5	1.5	0.0	18.0	2.0	0.0	18.5	1.0	0.5
CA + MP	18.0	2.0	0.0	17.0	2.0	1.0	19.0	1.0	0.0
CA + GB	9.5	5.5	5.0	12.0	5.0	3.0	14.0	3.5	2.5
CA + BY40	11.0	6.5	2.5	15.0	3.0	2.0	17.5	1.5	1.0
GB	15.5	3.0	1.5	14.5	3.5	2.0	16.0	3.0	1.0
AHP1	17.5	2.0	0.5	18.5	1.5	0.0	18.5	1.5	0.0
AHP2	17.5	2.5	0.0	17.5	2.0	0.5	18.0	1.5	0.5

Evaluation of average grades of the fingermarks developed on fired cartridge cases following the slightly modified Bandey's grading scale (cf. Section 2.5).

Technique	Average grade[a]			Total average grade[b]
	24 h	7 days	14 days	
CA + RP	0.04	0.05	0.05	0.05
CA + MP	0.05	0.10	0.03	0.06
CA + GB	0.39	0.28	0.21	0.29
CA + BY40	0.29	0.18	0.09	0.18
GB	0.15	0.19	0.13	0.15
AHP1	0.08	0.04	0.04	0.05
AHP2	0.06	0.08	0.06	0.07

[a] Average grade obtained by two independent examiners for sets of 20 fired cartridge cases.
[b] Total average grade obtained over the three periods of time (24 h, 7 days, 14 days).

NOTE: 1A = detail close to cartridge base
1B = detail away from cartridge base

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Introduction

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Evaluation of fingermark detection sequences on paper substrates

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Physical developer
Nile red

ABSTRACT

It is generally accepted that the amino acid reagent consisting of 1,2-indanedione and a catalytic amount of zinc chloride, referred to as IND-Zn, is the single best method for the detection of latent fingermarks on paper substrates and that ninhydrin is of limited value when used in sequence after this reagent. However, recent research has suggested that the sequence 1,8-diazafluoren-9-one (DFO) followed by ninhydrin may actually produce a greater number of fingermarks than IND-Zn on its own or IND-Zn followed by ninhydrin.

This study focussed on the evaluation of two fingermark detection sequences for porous surfaces: (1) IND-Zn followed by ninhydrin, physical developer (PD) and the lipid stain nile red; and (2) DFO followed by ninhydrin, PD and nile red. The evaluation was undertaken using a range of latent fingermark donors and on a number of paper substrates that are commonly encountered in Australia. In addition, a pseudo-operational trial was completed on 5-year-old university examination booklets. Parallel studies were undertaken at two locations: Sydney (temperate, coastal climate) and Canberra (relatively dry, continental climate).

The results of the donor study indicated that there was a negligible difference in performance between the two sequences across all paper types and all time periods evaluated. When considering individual reagents, IND-Zn generally developed better quality fingermarks compared to DFO; however, ninhydrin had a greater enhancement effect on DFO developed marks than after IND-Zn. In the pseudo-operational trials, the IND-Zn sequence outperformed the DFO sequence. Nile red did not develop any additional marks at the end of each sequence and, as a result, the use of this technique at the end of a full sequence is of questionable value.

The overall outcome was that the sequence IND-Zn followed by ninhydrin and PD is recommended for the processing of common paper substrates under the conditions typically experienced at the two locations studied.

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1. Introduction

The detection and enhancement of latent fingermarks requires the application of an appropriate sequence of methods that will depend on the nature of the surface, the circumstances of the case under investigation, and the resources available to the fingerprint technician. Such sequences, consisting of complementary detection methods from least destructive to more destructive, need to be optimised and validated under local conditions before casework implementation. For paper substrates, the generally accepted approach is to apply non-destructive optical methods first, followed by one or more amino acid reagents, then a method – such as physical developer – that targets any sebaceous material that may be present [1].

The traditional amino acid reagent for fingermark detection is ninhydrin, which was first proposed for this application in 1954 [2]. Ninhydrin remains the most common chemical method for the treatment of paper substrates despite significant research efforts directed at the synthesis of ninhydrin analogues [3,4]. The first potential alternative to ninhydrin to be introduced into routine casework was 1,8-diazafluoren-9-one (DFO), originally proposed as a fingermark reagent in 1990 [5]. However, rather than replacing ninhydrin, DFO proved to be effective when used in a sequence prior to ninhydrin treatment, with early indications that ninhydrin can develop additional fingermarks not detected by DFO [6].

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- Marriott C, Lee R, Wilkes Z, Comber B, Spindler X, Roux C, Lennard C. Evaluation of Fingermark Detection Sequences on Paper Substrates. *Forensic Sci Int* 2014;236:30-37.
- The goal of this project was to determine the most efficient sequence of reagents for developing prints on paper substrates.
- Two sequences were evaluated:
  (1) IND-Zn → ninhydrin → PD → Nile red
  (2) DFO → ninhydrin → PD → Nile red

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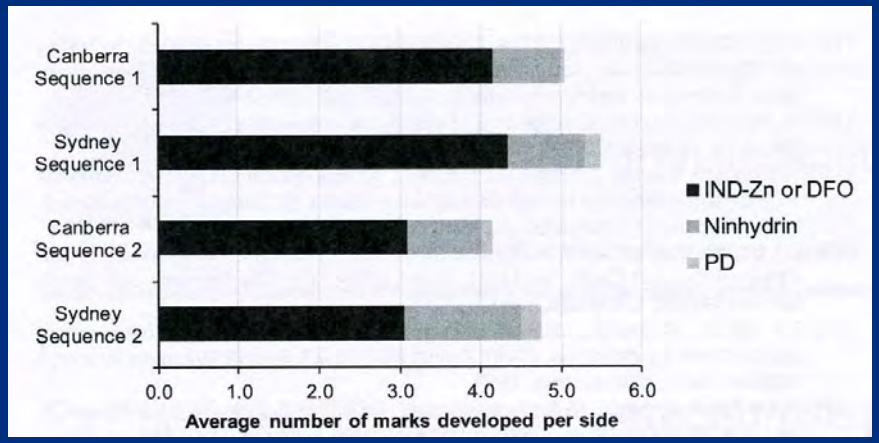
Results

- Experiments performed in Sydney and Canberra, Australia.
- Phase 1 involved donor trials (18 total donors; 4 substrates).
- Phase 2 involved pseudo-operational trials using 5-year-old university examination booklets (number of prints developed per side of page).
- Nile red did not develop any print detail; PD acted adversely to 3 out of 4 papers and developed only a limited number of additional prints.
- Ninhydrin had better performance after DFO than after IND-Zn.
- Phase 1: neither sequence outperformed the other (statistically).
- Phase 2: (Canberra): S1 developed 21% more prints than S2; (Sydney) S1 developed 16% more prints than S2.

Results



Results from the pseudo-operational trials on 5-year-old university examination booklets. (*Note*: To be counted, developed marks had to have a HO rating of 2 or above.).

	Sequence 1 (IND-Zn)		Sequence 2 (DFO)	
	Canberra	Sydney	Canberra	Sydney
No. pages/sides	40/80	10/20	40/80	10/20
No. marks with IND-Zn or DFO	332	87	248	61
No. marks with ninhydrin	67	19	73	29
No. marks with PD	5	4	12	5
Total marks for full sequence	404	110	333	95
Avg. marks per side: IND-Zn or DFO	4.2	4.4	3.1	3.1
Avg. marks per side: ninhydrin	0.8	1.0	0.9	1.5
Avg. marks per side: PD	0.1	0.2	0.2	0.3
Avg. marks per side: full sequence	5.1	5.5	4.2	4.8

- Phase 2 results (pseudo-operational trials) indicated that the IND-Zn sequence produced a higher average number of prints per page side than the DFO sequence.

Introduction

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An investigation into the enhancement of sea-spray exposed fingerprints on glass

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ABSTRACT

Fingerprints are considered one of the best forms of personal identification. While numerous enhancement techniques exist to develop fingerprints under various conditions, the enhancement of fingerprints exposed to sea spray aerosol (SSA) still remains problematic.

1056 fingerprints from four donors, using a depletion series and triplicate repeats, were deposited onto glass panels and exposed to SSA for 1 week and 1 month.

Control prints were deposited in the same manner and left under laboratory conditions.

All prints were enhanced using fingerprint enhancement techniques available to Forensic Police Officers and subsequently examined for identifiability by a Fingerprint Expert.

Significantly fewer identifiable prints ($p < 0.01$) were developed after exposure to SSA for 1 month (11%) compared to exposure for 1 week (69%) (compared to the control prints 99%) for all enhancement techniques.

After 1 week's exposure, all techniques enhanced over 50% of prints, except SPR white (12%), with iron (III) oxide and Wetwop™ white producing over 90% identifiable prints.

Only iron (III) oxide, Wetwop™ white and SPR black returned any identifiable prints following 1 month's SSA exposure. Iron (III) oxide being significantly better ($p < 0.01$, 67%) than the other techniques.

Iron (III) oxide suspension and Wetwop™ white were found to be superior at enhancing prints at both SSA exposure times.

1. Introduction

Numerous fingerprint enhancement techniques have been developed to enhance fingerprints on both porous and non-porous surfaces with great success [1]. Further developments have also been made to enhance prints after exposure to challenging environmental factors such as prints on wetted items [2], on the sticky side of tape [3], aged prints [4] and prints exposed to extreme temperatures [5].

Although the effects of multiple environmental factors on fingerprints have been explored, the effects of sea spray aerosol (SSA) have not yet been investigated.

Airflow, temperature, sunlight, humidity and water can all influence the durability of a print and as such can affect enhancement success [9]. High airflow and a high surface temperature can cause prints to rapidly dry out [9], while a high environmental temperature can cause the fats and oils to degrade [2].

Sea spray is generally deposited from the natural action of wind over the ocean [6]. A print that is exposed to SSA will consequently be exposed to potentially damaging airflow and salt particles.

A survey conducted with 20 Gold Coast Crime Scene Officers indicated that fingerprints could not be recovered from approximately 8–12% of all crime scenes due to SSA exposure (Finigan, A., Personal Communication, February 11, 2013).

Since the Gold Coast of Australia consists of 27 km of coastline and 260 km of navigable waterways [16] countless numbers of non-porous surfaces in water front dwellings are potentially being SSA exposed, preventing successful print enhancement.

The aim of this study was to find the most effective fingerprint enhancement technique for prints exposed to SSA at two time frames; 1 week and 1 month.

2. Materials and methods

Four donors, two male and two female, participated in this study.

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0379-0738/

- Goldstone SL, Francis SC, Gardner SJ. An Investigation into the Enhancement of Sea-spray Exposed Fingerprints on Glass. *Forensic Sci Int* 2015;252:33-38.
- The goal of this project was to examine the impact of aerosolized sea spray on latent prints deposited on glass for up to 1 week and 1 month.
- A previous, unpublished survey of Gold Coast (Australia) SOCOs indicated that prints could not be recovered in 8-12% of all crime scenes there due to sea spray exposure.

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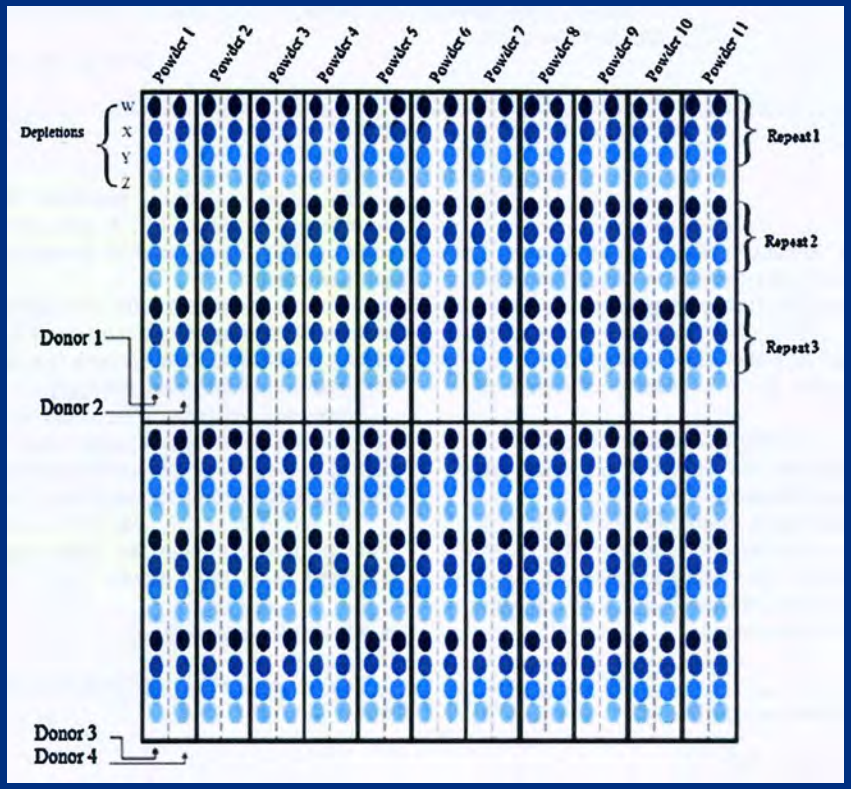
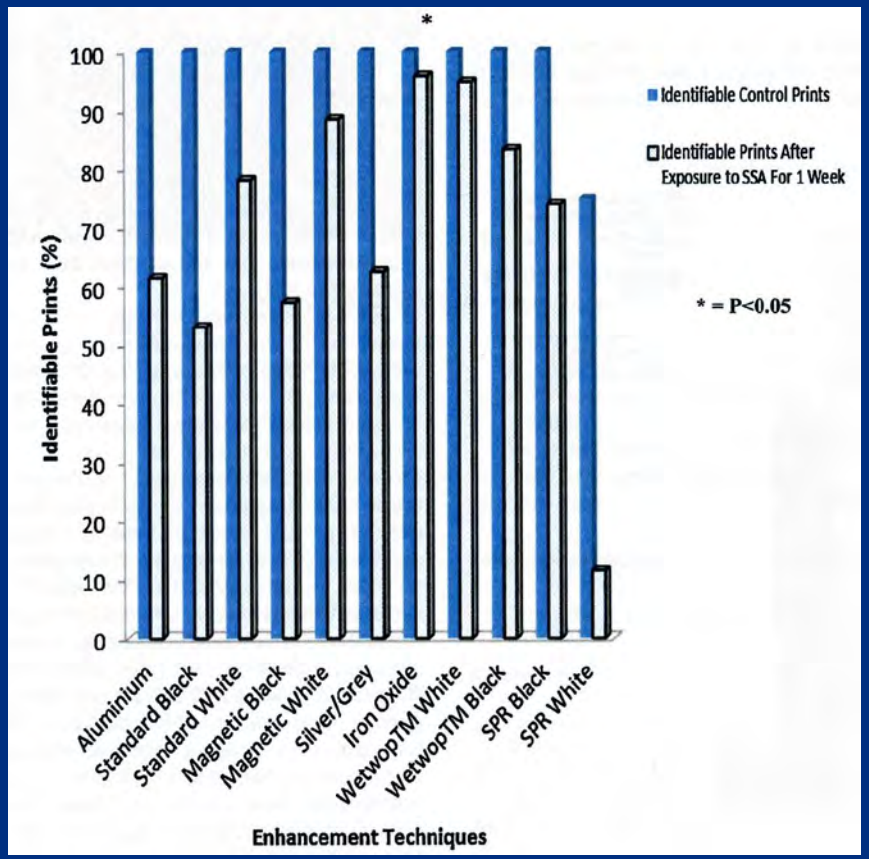
Results


Powder 1
Powder 2
Powder 3
Powder 4
Powder 5
Powder 6
Powder 7
Powder 8
Powder 9
Powder 10
Powder 11
Depletions
W
X
Y
Z
Repeat 1
Repeat 2
Repeat 3
Donor 1
Donor 2
Donor 3
Donor 4


*
100
90
80
70
60
50
40
30
20
10
0
Identifiable Prints (%)
Identifiable Control Prints
Identifiable Prints After Exposure to SSA For 1 Week
* = P<0.05
Aluminium
Standard Black
Standard White
Magnetic Black
Magnetic White
Silver/Grey
Iron Oxide
WetwopTM White
WetwopTM Black
SPR Black
SPR White
Enhancement Techniques

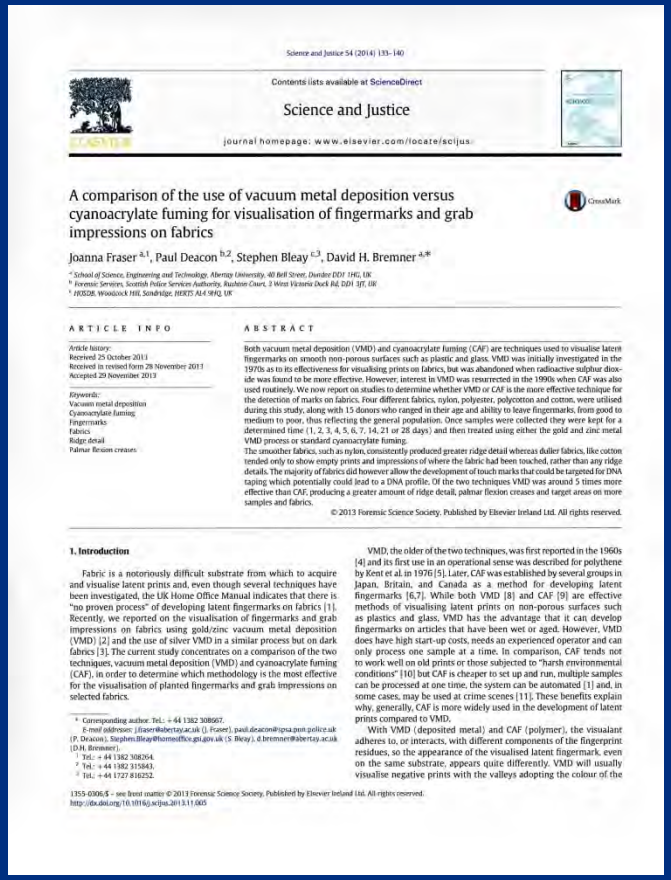
Results

- Two large glass panels were placed approximately 100 m from ocean.
- The best visualization methods were determined to be iron (III) oxide powder suspension (96%, 1 week; 67% 1 month) and Wetwop™ white (95%, 1 week; 49%, 1 month).

Comparison of the combined number of fingerprints deposited on panels A and B to the number of fingerprints deemed identifiable, after exposure to SSA for 1 week and 1 month.

Enhancement technique	1 Week			1 month		
	No. of prints deposited	No. of prints identifiable	% Success	No. of prints deposited	No. of prints identifiable	% Success
Aluminium powder	96	59	62	96	0	0
Standard black powder	96	51	53	96	0	0
Standard white powder	96	75	78	96	0	0
Magnetic black powder	96	55	57	96	0	0
Magnetic white powder	96	85	89	96	3	3
Silver-grey powder	96	60	63	96	0	0
iron (III) oxide suspension	96	92	96	96	64	67
Wetwop™ white	96	91	95	96	47	49
Wetwop™ black	96	80	83	96	0	0
SPR black	96	71	74	96	1	1
SPR white	96	11	12	96	–	–
Total	1056	730	69	1056	115	11

Introduction



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A comparison of the use of vacuum metal deposition versus cyanoacrylate fuming for visualisation of fingermarks and grab impressions on fabrics

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ABSTRACT

Both vacuum metal deposition (VMD) and cyanoacrylate fuming (CAF) are techniques used to visualise latent fingermarks on smooth non-porous surfaces such as plastic and glass. VMD was initially investigated in the 1970s as to its effectiveness for visualising prints on fabrics, but was abandoned when radioactive sulphur dioxide was found to be more effective. However, interest in VMD was resurrected in the 1990s when CAF was also used routinely. We now report on studies to determine whether VMD or CAF is the more effective technique for the detection of marks on fabrics. Four different fabrics, nylon, polyester, polycotton and cotton, were utilised during this study, along with 15 donors who ranged in their age and ability to leave fingermarks, from good to medium to poor, thus reflecting the general population. Once samples were collected they were kept for a determined time (1, 2, 3, 4, 5, 6, 7, 14, 21 or 28 days) and then treated using either the gold and zinc metal VMD process or standard cyanoacrylate fuming.
The smoother fabrics, such as nylon, consistently produced greater ridge detail whereas duller fabrics, like cotton tended only to show empty prints and impressions of where the fabric had been touched, rather than any ridge details. The majority of fabrics did however allow the development of touch marks that could be targeted for DNA taping which potentially could lead to a DNA profile. Of the two techniques VMD was around 5 times more effective than CAF, producing a greater amount of ridge detail, palmar flexion creases and target areas on more samples and fabrics.

1. Introduction

Fabric is a notoriously difficult substrate from which to acquire and visualise latent prints and, even though several techniques have been investigated, the UK Home Office Manual indicates that there is "no proven process" of developing latent fingermarks on fabrics [1]. Recently, we reported on the visualisation of fingermarks and grab impressions on fabrics using gold/zinc vacuum metal deposition (VMD) [2] and the use of silver VMD in a similar process but on dark fabrics [3]. The current study concentrates on a comparison of the two techniques, vacuum metal deposition (VMD) and cyanoacrylate fuming (CAF), in order to determine which methodology is the most effective for the visualisation of planted fingermarks and grab impressions on selected fabrics.

VMD, the older of the two techniques, was first reported in the 1960s [4] and its first use in an operational sense was described for polythene by Kent et al. in 1976 [5]. Later, CAF was established by several groups in Japan, Britain, and Canada as a method for developing latent fingermarks [6,7]. While both VMD [8] and CAF [9] are effective methods of visualising latent prints on non-porous surfaces such as plastics and glass, VMD has the advantage that it can develop fingermarks on articles that have been wet or aged. However, VMD does have high start-up costs, needs an experienced operator and can only process one sample at a time. In comparison, CAF tends not to work well on old prints or those subjected to "harsh environmental conditions" [10] but CAF is cheaper to set up and run, multiple samples can be processed at one time, the system can be automated [1] and, in some cases, may be used at crime scenes [11]. These benefits explain why, generally, CAF is more widely used in the development of latent prints compared to VMD.

With VMD (deposited metal) and CAF (polymer), the visualant adheres to, or interacts, with different components of the fingerprint residues, so the appearance of the visualised latent fingermark, even on the same substrate, appears quite differently. VMD will usually visualise negative prints with the valleys adopting the colour of the

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- Fraser J, Deacon P, Bleay S, Bremmer DH. A Comparison of the Use of Vacuum Metal Deposition Versus Cyanoacrylate Fuming for Visualisation of Fingermarks and Grab Impressions on Fabrics. *Sci & Just* 2014;54:133-140.
- Fabric types used in this study included: cotton, nylon, polyester, and polycotton (60% cotton/40% polyester blend).
- 600 fabric samples aged up to 28 days.
- Overall, VMD produced more ridge and palmar flexion detail than did CA fuming.

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Results - VMD

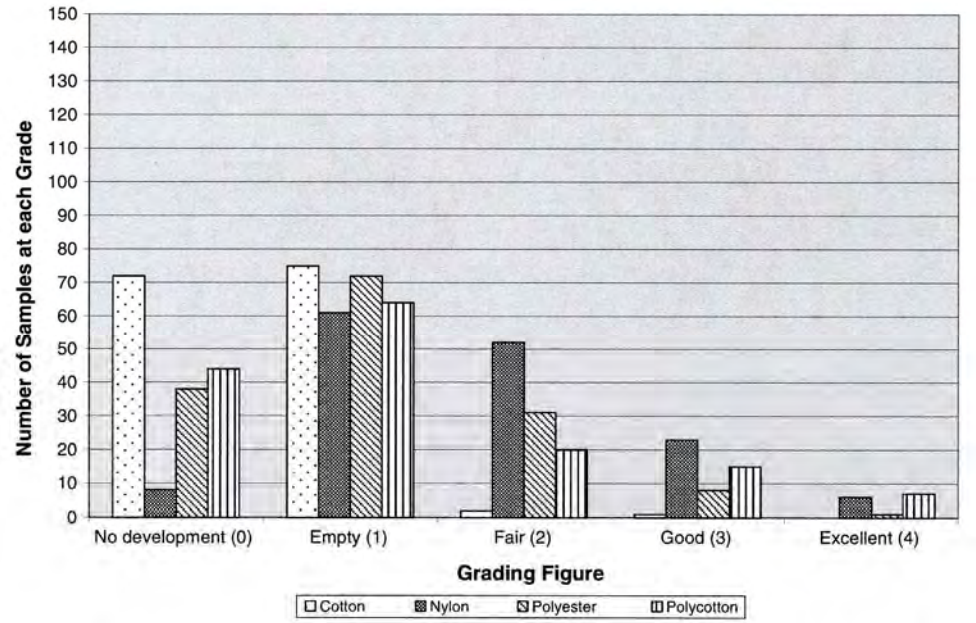

Fig. 1. Overall grading from 0 (No development) to 4 (Excellent) of samples on all fabric types visualised with VMD.

- Cotton showed only one sample with ridge detail.
- Nylon had 47 positive samples on all days (except for 28).
- Polycotton (all days).
- Polyester (except 6 and 28).

Results – CA Fuming

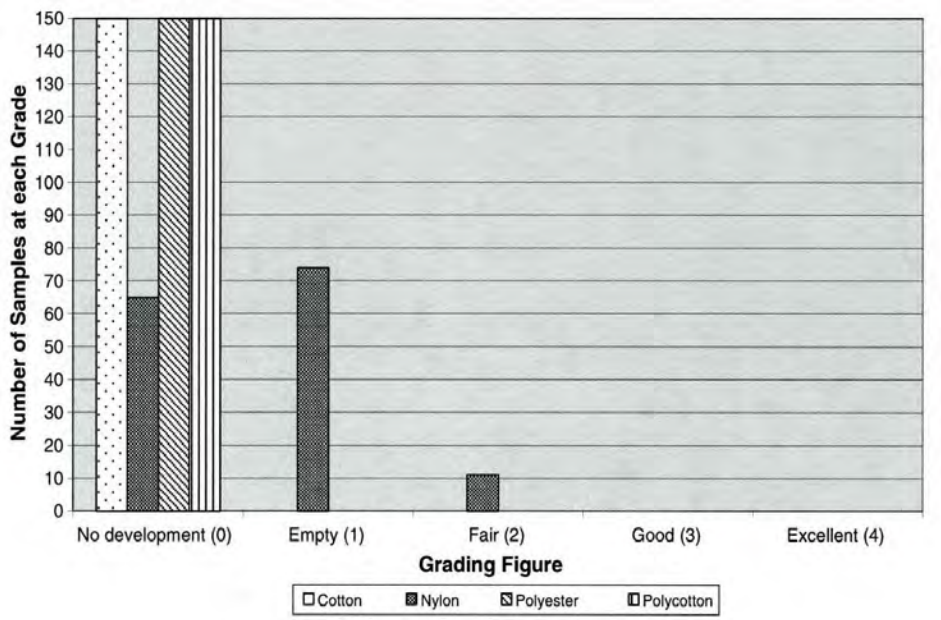

Fig. 2. Overall grading from 0 (No development) to 4 (Excellent) of samples on all fabric types visualised with CAF.

- 85.8% of all samples graded as "0" or as "No Development".
- 9% samples indicated an impression (for possible DNA collection).
- Only 1.8% of nylon samples showed any ridge detail

Introduction

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Short Communication

ESDA®-*Lite* collection of DNA from latent fingerprints on documents

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ABSTRACT

The ability to detect and non-destructively collect biological samples for DNA processing would benefit the forensic community by preserving the physical integrity of evidentiary items for more thorough evaluations by other forensic disciplines. The Electrostatic Detection Apparatus (ESDA®) was systemically evaluated for its ability to non-destructively collect DNA from latent fingerprints deposited on various paper substrates for short tandem repeat (STR) DNA profiling. Fingerprints were deposited on a variety of paper substrates that included resume paper, cotton paper, magazine paper, currency, copy paper, and newspaper. Three DNA collection techniques were performed: ESDA collection, dry swabbing, and substrate cutting. Efficacy of each collection technique was evaluated by the quantity of DNA present in each sample and the percent profile generated by each sample. Both the ESDA and dry swabbing non-destructive sampling techniques outperformed the destructive methodology of substrate cutting. A greater number of full profiles were generated from samples collected with the non-destructive dry swabbing collection technique than were generated from samples collected with the ESDA; however, the ESDA also allowed the user to visualize the area of interest while non-destructively collecting the biological material. The ability to visualize the biological material made sampling straightforward and eliminated the need for numerous, random swabbings/cuttings. Based on these results, the evaluated non-destructive ESDA collection technique has great potential for real-world forensic implementation.

1. Introduction

The ability to successfully detect, collect, and process individual biological samples from various evidentiary substrates without causing surface damage is a challenge in the field of forensics. The damage inflicted to an evidence item during sample collection may prevent additional evaluations of the object. Traditional methods of recovering DNA from forensic samples typically rely on the use of chemical sprays, wet/dry cotton tip swabbing, or substrate cuttings [1–7]. While these traditional techniques effectively collect biological material, they can leave evidence items in an altered or damaged state. Chemical sprays, such as Ninhydrin, are utilized frequently by forensic investigators in order to locate amines left behind by sloughed off cellular debris [8,9], but the use of this chemical may destroy the integrity of the evidence, rendering it unusable for further forensic testing. The wet/dry double swab technique is a highly employed collection method used for the sampling of biological deposits on a wide variety of items, but this methodology typically causes tearing and blotting when used to sample paper documents. Substrate cuttings provide DNA analysts with small clippings of the original sample that can yield ample amounts of DNA through the extraction process [6]; however, this type of sampling is also very destructive as it involves physically removing segments of evidence. Although these sampling techniques represent effective means of collecting DNA, they are often destructive and can damage evidentiary items, which limits their usefulness to other forensic disciplines.

Non-destructive collection techniques are needed in the forensic community to supplement established destructive methods of sampling biological material. Forensic DNA analysts would benefit from a technique that allows for the detection and collection of biological materials from an item without damaging its structural integrity or interfering with any subsequent examinations. The additional information gained from questioned documents, entry point surfaces, various clothing items, and other items containing touch DNA evidence processed in this manner could aid in the conviction or exoneration of individuals. Evidence processed in a non-destructive manner would also remain available for future evaluations, which could prove pivotal to the outcome of a cold case investigation or criminal retrial.

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1872-4973/

- Plaza DT, Mealy JL, Lane JN, Parsons MN, Bathrick AS, Slack DP. ESDA-Lite Collection of DNA from Latent Fingerprints on Documents. *Forensic Sci Int: Gen* 2015;16:8-12.
- The goal of this project was to determine if the ESDA®-lite could non-destructively collect DNA from latent prints on various paper substrates.
- Mylar film comes in contact with document during indented writing analysis.
- Three collection methods employed: ESDA®-lite collection; dry swabbing; and substrate cutting.

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Results

- 54 latent prints were sampled for each of the 3 detection methods.
- Across all substrates tested, the percentage of samples yielding full or high partial DNA profiles were: 65% for the ESDA®-lite; 93% non-destructive dry swabbing; and 52% for destructive cutting.
- The dry swabbing collection method outperformed all other collection methods on every substrate except newspaper (direct substrate cutting worked best).
- The amount of epithelial cells shed by the donor onto the latent print had the largest impact on reproducibility of results.
- The ESDA®-lite collection method developed an investigative lead from a document handled by POI less than a week prior to handling.

Results

Full profiles generated from the fingerprint samples deposited on various paper substrates and collected via the ESDA-*Lite*, dry swabbing, and destructive (material cutting or wet/dry swabbing) collection techniques.

Substrate	ESDA collection				Dry swabbing collection				Destructive collection			
	N	Full profiles	High partial profiles	Full and high partial (%)	*N*	Full Profiles	High partial profiles	Full and high partial (%)	*N*	Full profiles	High partial profiles	Full and high partial (%)
Resume paper	9	3	3	67%	9	8	1	100%	9	0	1	11%
Cotton paper	9	4	3	78%	9	8	0	89%	9	0	0	0%
Magazine paper	9	3	4	78%	9	7	2	100%	9	2	4	67%
Currency	9	3	2	56%	9	8	1	100%	9	1	3	44%
Copy paper	9	5	2	78%	9	9	0	100%	9	5	3	89%
Newspaper	9	3	0	33%	9	5	1	67%	9	8	1	100%
Mid weight	36	13	12	69%	36	31	4	97%	36	3	8	31%
Standard weight	9	5	2	78%	9	9	0	100%	9	5	3	89%
Low weight	9	3	0	33%	9	5	1	67%	9	8	1	100%
Total	54	21	14	65%	54	45	5	93%	54	16	12	52%

Note: *N*: total samples.

Two-sample t-test comparisons of DNA quantity (ng) present in fingerprint samples collected via ESDA, dry swabbing, and destructive (material cutting or wet/dry swabbing) collection techniques.

Paper substrate	ESDA		Dry swabbing		Destructive		*p*-value		
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	ESDA vs dry swabbing	ESDA vs destructive	Dry swabbing vs destructive
Resume	0.367	0.601	0.521	0.348	0.061	0.097	0.516	0.170	0.004*
Cotton	0.217	0.264	0.547	0.519	0.000	0.000	0.115	0.039*	0.013*
Magazine	0.332	0.308	1.049	1.186	0.130	0.149	0.113	0.102	0.050
Currency	0.320	0.696	0.623	0.319	0.187	0.184	0.260	0.592	0.003*
Copy	0.170	0.185	0.798	0.460	0.550	0.881	0.003*	0.237	0.468
Newspaper	0.170	0.226	0.267	0.245	0.677	0.453	0.400	0.011*	0.030*

Notes: $^*p < 0.05$ (two-tailed test); $\bar{X}$: mean; SD: standard deviation.

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