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Forensic Aspects of the Study
of Latent Papillae Pattern Prints
on the Epidermis of a Deceased Person

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Table of Contents

Introduction.....	4
Topicality of the Thesis.....	7
Novelty of the Thesis.....	8
Aim of the Thesis.....	9
Tasks of the Thesis.....	9
Research questions of the Thesis.....	10
1 Human skin as a trace-leaving and a trace-bearing object.....	14
1.1 Human skin relief and papillae pattern print forming objects.....	15
1.2 Genesis of papillae pattern prints and factors affecting it.....	16
2 Forensic aspects of retention and preservation of papillae pattern prints on human skin.....	22
2.1 Factors affecting retention of papillae pattern prints.....	23
2.2 Preconditions for preservation of papillae pattern prints.....	26
3 Analysis of technological solutions for visualisation of latent papillae pattern prints.....	28
3.1 Dactyloscopic powders.....	28
3.2 Direct transfer method.....	30
3.3 Iodine fuming.....	31
3.4 Cyanoacrylate ester.....	33
3.5 Ruthenium Tetroxide and Rhodamine 6G.....	35
4 An experiment on visualisation and recovery of latent papillae pattern prints from the epidermis of a deceased person.....	38
4.1 Materials and methods.....	38
4.2 Results.....	40
4.3 Discussion.....	46
4.4 Legal framework of methods applied in forensic expert-examination and its development.....	48
Conclusions.....	50
List of publications and reports on the topic of the Thesis.....	64
References.....	77
Acknowledgements.....	81
Annexes.....	82
Annex 1.....	83
Annex 2.....	84
Annex 3.....	85

Introduction

The following key elements can be distinguished in the genesis and detection of crime: person, crime, traces, and identification.

“Looking at the history of the world, there is no real reason to believe that crime is a transient phenomenon. All socio-economic formations, all their patterns of implementation show that crime is an integral and inevitable part of society, despite all its changes.”¹

Although crime is a historically changing phenomenon, the killing of a person is one of the oldest and most serious offences. The author shares the recognition that forensics plays “the most active role in the study, detection, investigation and prevention of crime”.² Nowadays, forensics introduces a wide range of technical tools and technological solutions to facilitate the detection, recording and seizure of different types of evidence, which in turn has an impact on the detection of a criminal offence, since evidence in criminal proceedings is always about investigating past events.³

One type of evidence in criminal proceedings is material evidence, the importance of which in the variety of evidence is determined by its ability to leave traces, for example, as a tool of a criminal offence, and also to preserve traces, for example, as the object against which a criminal offence has been committed. Traces of different types play an important role as material evidence in the investigation and detection of criminal offence, as traces can be found on different types of objects – easily movable, difficult to move and non-movable – at the scene. One of the most common traces at the scene are papillae pattern

¹ Vilks, A. un Loskutovs, A. 1998. VII nodaļa. Noziedzība. Melne, M., Janaite, I. *Kriminoloģija. Mācību grāmata juridiskām augstskolām un fakultātēm*. Rīga: Nordik izdevniecība, 136.

² Grieznis, P. 2000. *Praktiskā kriminālistika*. Rīga: Likuma vārdā, 5.

³ Jākobsone, V. 1998. Pierādījumu un pierādīšanas pasaulē. *Administratīvā un kriminālā justīcija*. 2/98, 8.

prints, the phenomenon of which lies in the possibility of being found on different types of objects, such as banknotes,⁴ cartridges,⁵ fabric,⁶ chalk,⁷ bird eggs,^{8,9} bird feathers,¹⁰ fruit and vegetables,¹¹ plant leaves.¹² As can be seen from these examples, papillae pattern prints can be found at the scene on flat and uneven, porous and non-porous surfaces, as well as on objects that are seasonal in our latitudes, such as the leaves of outdoor plants and deciduous trees.

Although nowadays a person can be identified by homeoscopic, odorological and biological traces, as well as by biometric data, the cores also include a digital image of the face, fingerprints and handprints,¹³ it should be acknowledged that dactyloscopic traces are one of the oldest identifying traces

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- ⁴ Lachance, D., Jasra, P. K. and Jasra, S. K. 2016. Evaluation of Techniques for the Visualization of Latent Fingerprints on Canadian Polymer Banknotes. *Journal of Emerging Forensic Sciences Research*. 1(22), 57–66.
- ⁵ Girelli, C. M. A. et.al. 2015. Comparison of practical techniques to develop latent fingerprints on fired and unfired cartridge cases. *Forensic Science International*. 250, 17–26. <https://doi.org/10.1016/j.forsciint.2015.02.012>
- ⁶ Li, P., Li, C. and Li, J. 2022. Development of Sweat Latent Fingerprints on Common Coated Fabrics. *Journal of Materials, Processing and Design*. 6(2). DOI: 10.23977/jmpd.2022.060205
- ⁷ Jasuja, O. P., Singh, K. 2017. Recovery of Latent Fingerprints from Chalk. *Journal of Forensic Identification*. 60/67(1), 60–69.
- ⁸ Stolić, I. et.al. 2019. Visualization of latent fingerprints on the surface of quail eggshells. *Veterinarska Stanica*. 5 (4), 337-344.
- ⁹ Darby, A. et.al.2015. Visualisation of Latent Fingerprint on Wild Bird Eggshells by Alternate Light Sources Following Superglue Fuming. *Forensic Research*.. 6(3.). 1–5. <http://dx.doi.org/10.4172/2157-7145.1000286>
- ¹⁰ McMorris, H., Farrugia, K. and Gentles, D. 2015. An investigation into the detection of latent marks on the feathers and eggs of birds of prey. *Science & Justice*. 55 (2). 90-96. <https://doi.org/10.1016/j.scijus.2014.12.004>
- ¹¹ Hong, S. et.al. 2018. Development of Latent Fingerprints on Surfaces of Food-A More Realistic Approach. *Journal of Forensic Sciences*. 64(4),1040-1047. doi: 10.1111/1556-4029.13960
- ¹² Sīda, R., Zīle, A. 2016. Papillārliņiju rakstu pēdu vizualizēšanas un izņemšanas iespējas no bioloģiskām virsmām – teorētiskie un praktiskie aspekti. Administratīvā un kriminālā justīcija. 4(77), 3–11.
- ¹³ Biometrijas datu apstrādes sistēmas likums: Latvijas Republikas likums. 10.06.2009. *Latvijas Vēstnesis*, 90.

of a person, which have not lost their importance in the diversity of material available today.

The importance of papillae pattern prints in forensics has three essential features: individuality (uniqueness), persistence and regeneration.

Individuality (uniqueness) means that the individuality of each papillae pattern is constituted by the individual set of special features of a papillae pattern it contains, which is different for each person and no two people have identical individual sets of special features of their papillae patterns, as Victor Balthazard, professor in forensic medicine in Paris, proved in his study.¹⁴

Persistence is explained by the formation of a papillae pattern during embryonic development and its complete destruction with the decomposition of the soft tissues of a corpse. The only natural changes in the papillae pattern occur as the child grows, with changes in the spacing between the papillary lines and their distinctive features, but this has no effect on the arrangement of the distinctive features of a papillae pattern and their interposition, nor on the individual set of these features which are the basis for identification of a person. The empirical basis for the consistency of a papillae pattern throughout a person's life was confirmed by the scientist William James Herschel.¹⁵

The ability of a papillae pattern to regenerate significantly increases the possibility of identifying a person because even after mechanical, thermal, chemical or other damage to the papillary lines, they regenerate over time, but if the deeper layers of the skin are damaged, a scar is formed, which is in itself a special feature that can be used to identify a person. In the history of

¹⁴ Balthazard, V. 1911. De la certitude dans l'identification par les empreintes digitales. *Bulletin de la Société de Médecine légale*. Tome 8, 106–115. <https://criminocorpus.org/fr/bibliotheque/doc/624/>

¹⁵ Herschel, W.J. 1916. *The origin of finger-printing*. Humphrey Milford Oxford University Press. London. Edinburgh. Glasgow. New York. Toronto. Melbourne. Bombay.30. <https://www.gutenberg.org/files/34859/34859-h/34859-h.htm>

dactyloscopy there were attempts made to destroy papillae patterns on fingernail phalanges using various methods.

By studying and analysing the history of dactyloscopy, it can be concluded that in the course of its development a very large empirical base has been collected, compiled and studied, which formed the scientific research material of dactyloscopy and strengthened its role in identification of a person and detection of criminal offences.

Topicality of the Thesis

In the current conditions of transformation, dactyloscopy continues to evolve in search of new opportunities, for example, one of the most important areas of research is the identification and exploration of new trace-bearing surfaces that could significantly contribute to the detection of criminal offences. One of the most important trace-bearing surfaces is the skin, the largest human organ covering the entire body. Admittedly, the situation is unique, as human skin can be both a trace-leaving object (papillary lines on the palm and fingers) and a trace-bearing object (skin on any other part of the human body). The uniqueness of the corpse as an object of study, both from a point of view of forensic medicine and forensics, is beyond doubt, since its examination provides the greatest amount of information about a criminal offence, especially in situations where the location of the corpse is not the scene of the offence. Similarly, papillae pattern prints on a corpse can occur both at the time of committing a criminal offence and afterwards, for example, when the corpse is moved.

Although there are positive cases of visualisation of latent papillae pattern prints on human skin in foreign practice, no fundamental research has been carried out in this field in Latvia. According to the author, this is due to the fact that there are several important factors that affect the leaving, retention, preservation, visualisation, fixation and recovery of the prints.

Maira Čentoricka, head of the State Forensic Science Bureau, in her monograph, “Pirkstu pēdu atklāšanas un izņemšanas līdzekļi un metodes”¹⁶ and Ojārs Teteris, chairman of the Scientific and Methodological Council of the State Forensic Science Bureau, in his monograph “Tiesu medicīnas esence”¹⁷ have pointed to the fact that the possibility of searching for possible papillae pattern prints on the skin of a deceased person is not used in Latvia.

So far, no systematic study has been carried out in Latvia on the visualisation of latent papillae pattern prints on the skin of a deceased person, which could be the basis for registration of the method in the Council of Forensic Experts and its implementation in practice as required by the laws and regulations governing the application of the method.

Novelty of the Thesis

The novelty of the Thesis consists in the theoretical and practical study of the visualisation of latent papillae pattern prints on the epidermis of a deceased person.

Firstly, studying the genesis of the papillae pattern prints as a result of the interaction of the trace-forming objects, identifying and analysing the factors affecting the genesis of it.

Secondly, the factors of retention and preservation of papillae pattern prints, their interaction and impact on the visualisation of papillae pattern prints were identified and studied. A possible transport packaging for the preservation of papillae pattern prints on the epidermis of a deceased person was modelled.

Thirdly, the methods used in foreign research and practice, their prerequisites for application, positive and negative factors were studied.

¹⁶ Čentoricka, M.2002. *Pirkstu pēdu atklāšanas un izņemšanas līdzekļi un metodes*. Rīga: Latvijas Vēstnesis, 91.

¹⁷ Teteris, O. 2004. *Tiesu medicīnas esence*. Rīga: Apgāds „Rasa ABC”.127.

Fourthly, the experiment was carried out independently and its results were analysed, correlating the initial data with the results of the experiment carried out by the author and by foreign scientists.

The theoretical significance of the Thesis is determined (emphasised) by the theoretical knowledge expressed about the genesis of the papillae pattern print; improvement of terminology by separating the terms “retention” and “preservation”, reflecting this in the analysis of causes and effects; correlation of initial data and results of experiments.

Aim of the Thesis

To conduct a theoretical and practical study on the visualisation of latent papillae pattern prints on the epidermis of a deceased person, identifying potential forensic and technological challenges and issues and providing proposals for improvement of their solution.

Tasks of the Thesis

The tasks of the Thesis are as follows:

- 1) to study human skin as a trace-forming and trace-bearing object, by analysing the genesis of the papillae pattern print and the factors affecting it;
- 2) to study and analyse retention and preservation of papillae pattern prints on the skin of a deceased person and their impact on the visualisation of them;
- 3) to study and analyse visualisation methods of latent papillae pattern prints and positive and negative aspects of their application;
- 4) within the framework of the method approbation, to carry out an experiment by studying and analysing its initial data and results in correlation with the initial data and results of experiments carried out

abroad, to propose the improvement of regulatory enactments by making the necessary amendments.

The object of the Thesis is visualisation of latent papillae pattern prints on the epidermis of a deceased person.

The subject of the Thesis is the forensic aspects affecting the visualisation of latent papillae pattern prints on the epidermis of a deceased person (trace-forming objects; genesis of papillae pattern print formation; retention and preservation of traces; methods of visualisation of traces and possibilities of their applications).

Research questions of the Thesis

The research questions of the Thesis are:

1. How do trace-forming objects affect the genesis of traces?
2. How visualisation of traces is affected by the factors of retention and preservation?
3. What is the most optimal method for visualisation of traces and what are the preconditions for its use?

In order to achieve the aim of the Thesis and to fulfil the tasks set, the following methods of scientific cognition formed the methodological basis of the study: modelling, experiment, observation, comparison, deduction, induction, analytical and monographic methods.

Modelling method was used to artificially create possible situations that may result in the leaving of experimental papillae pattern prints on a study object.

The experiment was carried out to study the possibility of formation of latent papillae pattern prints on the skin of a deceased person, the feasibility of visualisation and recovery of them, and the properties and combinations of adhesive and lifting agents.

The observation method was applied during the experiment by observing the interaction between trace-bearing object, the trace-leaving object and these objects, resulting in different trace reflections, as well as observing the adhesive properties of visualisation agent of the trace and the properties of lifting agents when copying the trace.

Comparative method was applied by comparing the initial data of the experiment carried out by the author and experiments carried out by foreign researchers, the results obtained and the opinions of other authors on the topic under study.

The analytical method was applied by analysing the initial data of the experiments and the results obtained, studying their correlation and analysing the opinions of other authors.

The method of deduction was applied to infer from theoretical knowledge and empirical evidence the individual aspects of the outcome of the interaction between the trace-bearing object and the trace-leaving object and the factors affecting it.

The method of induction was used to draw general conclusions from the empirical base.

The monographic method was applied to study special literature and describe the structure of human skin, the influence of early and late features of the corpse on the retention of papillae pattern prints, and to describe experiments carried out by the author and foreign researchers.

The author used methods of interpretation of legal norms in the Thesis:

The grammatical method of interpretation was applied to understanding the meaning of legal norms from a linguistic perspective.

The systematic method of interpretation was applied to the interpretation of legal norms regulating the activities of forensic experts.

The historical method of interpretation was applied to the development of the laws and regulations governing the activities of forensic experts.

The teleological method of interpretation was applied to explore the nature and meaning of legal norms.

The theoretical basis of the Thesis is formed by the scientific works of Latvian and foreign scientists and researchers in medicine, forensic medicine and forensic science.

In the framework of the research, the author has studied and analysed the works of Latvian scientists A. Kavalieris, P. Grieznis, O. Arajs, R. Dombrovskis, J. Konovalovs, M. Čentoricka, O. Teters, G. M. Rumans, Dz. M. Pilmans, P. Vasarins, A. Miltins, A. Smits and of foreign scientists L. Otomar, S. Schönborn, M. Bohnert, W. C. Sampson, K. L. Sampson, J. Straus, J. Kropáček, F. Dědičik, M. Trapecar, J. Balazic, K. B. Rozman, B. Dobovsek, G. J. Reichardt, J. C. Carr, E. G. Stone, S. L. Fortunato, G. Walton, L. M. P. Mehlretter, Y. Gülekçi, A. Tülek, H. Şener and H. Küçüker, J. M. Adcock, H. J. Hammer, D. Wilkinson, A. Misner, J. McMorris, A. M. Bohanan, I. R. Futrell, T. A. Trozzi and others.

The Thesis consists of four chapters and fourteen sub-chapters.

In the first chapter, human skin as a trace-leaving and trace-bearing object was studied in the framework of forensic and medical aspects and their influence on the genesis of the papillae pattern print.

In the second chapter, the concepts of retention and preservation were distinguished and defined on a theoretical and practical level, exploring and analysing their impact on the visualisation of papillae pattern prints.

In the third chapter, possible technological solutions and their potential for visualising latent papillae pattern prints on the epidermis of a deceased person were studied and analysed.

In the fourth chapter, the results of an experiment carried out independently by the author were presented and analysed. As part of the approbation of the physical method used in the experiment, the correlation of the initial data and results of the experiment carried out by the author and three foreign experiments was made, and the results obtained were analysed. Proposals have been made to improve the legal framework for the activities of an expert.

The results of the Thesis have been validated in the period from 2010 to 2023.

During the period from 1 June, 2017 to 31 August, 2017 the author independently conducted an experiment, the initial data, the course of the experiment and the results of which were published in the journal “Administratīvā un kriminālā justīcija” in 2017.

The correlation of the initial data and results of the experiment conducted by the author with the initial data and results of the experiment of researchers O. Lenertz, S. Schönborn, M. Bohnert within the joint project AGIS JLS/2006/AGIS/042(30-CE-0080807/00-07) of Austria, Denmark, UK and Germany and the joint project ISEC JLS/2009/ISEC/AG/184 of Denmark, Estonia, UK, Austria and Germany, was published in the journal “Administratīvā un kriminālā justīcija” in 2019.

During the approbation period, the author published 5 publications included in SCOPUS and ERIH PLUS international databases, 21 scientific articles in peer-reviewed journals published in Latvia and 4 scientific articles in peer-reviewed journals published abroad, in which the author validated the theoretical, practical and legal aspects of the topic under study, proposing possible solutions. The author has presented oral papers on the challenges and possible solutions of the research topic at 72 international scientific conferences in Latvia and abroad.

1 Human skin as a trace-leaving and a trace-bearing object

The functions of the skin (from Latin *cutis*) as the largest human organ are to protect the body from mechanical, chemical and thermal effects, as well as from microorganisms, to regulate body dehydration and body temperature, to participate in the general immune defence system of the body, to provide individual sensations such as touch, position, temperature, pain and feeling of pressure.¹⁸

In forensics human skin also plays an important role in identification of a person and solving criminal offences.

The scientist Mironov (А. И. Миронов) in his monograph “Трасологическое исследование следов рельефа кожи человека” (A Trasological Study of the Skin Relief of the Human Traces) indicated that the skin area of an adult is about 16,000 cm², and the papillae pattern area is about 850 cm², which is about 5 % of all skin area.¹⁹ This means that only about 5 % of human skin is used to identify a person, but while study of the relief of human skin Mironov concluded that a person can be identified by a fragment of the skin from any part of the human body, extending the possibilities of identifying a person by using the method of trasological research. But also, this possibility concerning identification of a person studied human skin only as a trace-leaving object rather than a trace-bearing object.

¹⁸ Rūmanss, G. M., Kažoka, Dz. un Pilmane, M. 2019. *Klīniskā anatomija medicīnas studentiem*. Rīga: Rīgas Stradiņa universitāte, 392.

¹⁹ Миронов, А.И. 1968. *Трасологическое исследование следов рельефа кожи человека*. Москва: МООП СССР Всесоюзный Научно – исследовательский институт Охраны общественного порядка. 3.

1.1 Human skin relief and papillae pattern print forming objects

Papillary lines form the skin relief on palms and fingers, soles and toes of a person, the height of which is 0.1–0.4 mm, but the width is 0.2–0.7 mm, and the width of the interpapillary line cavity is 0.1–0.3 mm.²⁰ There are output channels of sweat glands – pores – with a diameter of 0.08 to 0.25 mm on the surface of papillary lines. There are 9–18 pores on 1-cm-long papillary line surface, along which sweat emerges from the body. In cross section, papillary lines have a trapezoidal shape with a wavy upper base.²¹ On other parts of the human body the skin relief is formed by protrusions, cavities and pores of different type, size and configuration.

By studying and analysing the mechanism of formation of latent papillae pattern prints on human skin it can be concluded that all three trace-forming objects are involved in the process:

- 1) a trace-leaving object (papillary lines on the palm and fingers);
- 2) a trace-bearing object (human skin on any other part of the body);
- 3) a substance of a trace.

In order to better understand the formation of the composition of a trace-forming substance, each object involved in the genesis of latent papillae pattern prints will be considered separately.

A trace-leaving object (papillary lines on the palm and fingers) is naturally covered with sebum, which is the substance of the trace-forming object, secreted by the merocrine sweat glands.

²⁰ Кудинова, Н.С. 2018. *Криминалистика: основы современной дактилоскопии*. Саратов: Саратовский социально-экономический институт (филиал) РЭУ им. Г.В. Плеханова. 8.

²¹ Андрионова, В. А., Евсиков, В. Н., Зуев Е. И., Теткин С. И. 1957. *Сборник работ по криминалистике (дактилоскопическое исследование)* № 2. Москва: МВД СССР Научно – исследовательский институт милиции. 39.

A trace-bearing object (human skin on any other part of the body), depending on the part of the body, is naturally covered with sebum secreted by the apocrine or merocrine sweat glands and sebum secreted by the sebaceous glands, which is the substance of trace-bearing object.

It follows that in the process of formation of papillae pattern prints on human skin the composition of a substance of a trace consists of sebum and dead skin cells secreted by the merocrine sweat glands overlying the papillary lines of the palms and fingers and of apocrine or merocrine sweat gland sebum, sebaceous secretion and dead skin cells on human skin, depending on the body part.

Similarly, a trace-forming substance may contain impurities of other substances that have been deposited intentionally or unintentionally on a trace-forming object or a trace-bearing object, such as hand cream, suntan oil, or any other substance that has come into contact with another object on the surfaces of a trace-leaving object or a trace-bearing object.

When a trace-leaving object comes into contact with a trace-bearing object, mixing of substances on the surfaces of both objects occurs. This means that at the moment of contact, the substance of a trace-leaving object diffuses into the substance of a trace-bearing object and vice versa, so that the composition of a trace-forming substance can be very diverse.

1.2 Genesis of papillae pattern prints and factors affecting it

All three trace-forming objects are involved in the process of forming papillae pattern prints on human skin: a trace-leaving object – papillary lines, a trace-forming substance – sweat and grease substance and a trace-bearing object – human skin on any part of the body.

The presence of papillae pattern prints on human skin undeniably proves the fact of contact and indicates the place of contact and the possible mechanism of trace formation, such as grip or pressure.

Between 2014 and 2016 an experiment was carried out in Estonia and Latvia, the aim of which was to study and analyse the appearance of grip traces on human skin. The aim of the experiment carried out in Estonia was to simulate the movement of a corpse, but in Latvia the aim was to simulate the grip in the forearm during an attack by applying such pressure force that it would be impossible to free.²²

In both experiments only natural sweat and grease substance on the palms and fingers was used to leave papillae pattern prints, as well as the mechanism of trace formation was closely aligned with the real situation.

12 people – 11 men and 1 woman aged 22–35 – took part in the experiment of simulation of moving the corpse. Two men acted as movers. The movers were in good physical condition, weighing 85 kg and 125 kg. In turn, the body weight of the body of a woman to move was 55 kg, of two men – 73–75 kg, of other two men – 82–85 kg, of three men – 90–95 kg, of two men – 97.5–103.4 kg. The transfer distance was 22 m.²³

During the experiment of simulation of moving the corpse, it was stated that the heavier the person being moved was, the more the hands of the movers were sweating. Therefore, during moving, the movable person was repeatedly repositioned on the floor and re-gripped, resulting in new papillae pattern prints.²⁴

²² Lall, A., Zile, A. 2016. Experimental Series of Trace Formation on Human Skin During Arm Grip and Body Transportation. *International Research and Practice Juridical Journal Criminalist*. 12. 113. https://crimcongress.com/wp-content/uploads/2016/12/Criminalist_12_anons.pdf

²³ *Ibid.*, 114.

²⁴ *Ibid.*

12 persons – 9 women and 3 men aged 21–24 – were involved in the grip simulation experiment and they were simulating the grip. Twelve persons – 6 women and 6 men aged 21–24 were caught in the forearm area and their skin was both smooth and hairy and without hair.²⁵

Having studied the mechanism of formation of papillae pattern prints used during both experiments, it was found that the quality of the traces is significantly influenced by:

- 1) intensity of perspiration of sweat and grease substance during leaving a trace and depletion factor during the moving of the corpse while gripping repeatedly;
- 2) the pressure force applied during leaving a trace, under the influence of which the deformation of a trace can be observed, as the papillary lines expand and merge with each other;
- 3) the density of body hair at the place where a trace is left, which forms an intermediate layer between a trace-bearing object and a trace-leaving object, which the papillary lines cannot penetrate due to their fine structure, making it difficult or impossible to reflect the pattern of the papillary lines;
- 4) skin condition on which traces are left.²⁶

The author developed a diagram of the schematic causalities of the genesis of papillae pattern prints on human skin using the cause-and-effect diagram developed by Professor Kaoru Ishikawa. (Figure 1.1)

²⁵ Lall, A., Zile, A. 2016. Experimental Series of Trace Formation on Human Skin During Arm Grip and Body Transportation. *International Research and Practice Juridical Journal Criminalist*. 12. 115. https://crimcongress.com/wp-content/uploads/2016/12/Criminalist_12_anons.pdf

²⁶ *Ibid.*, 122–123.

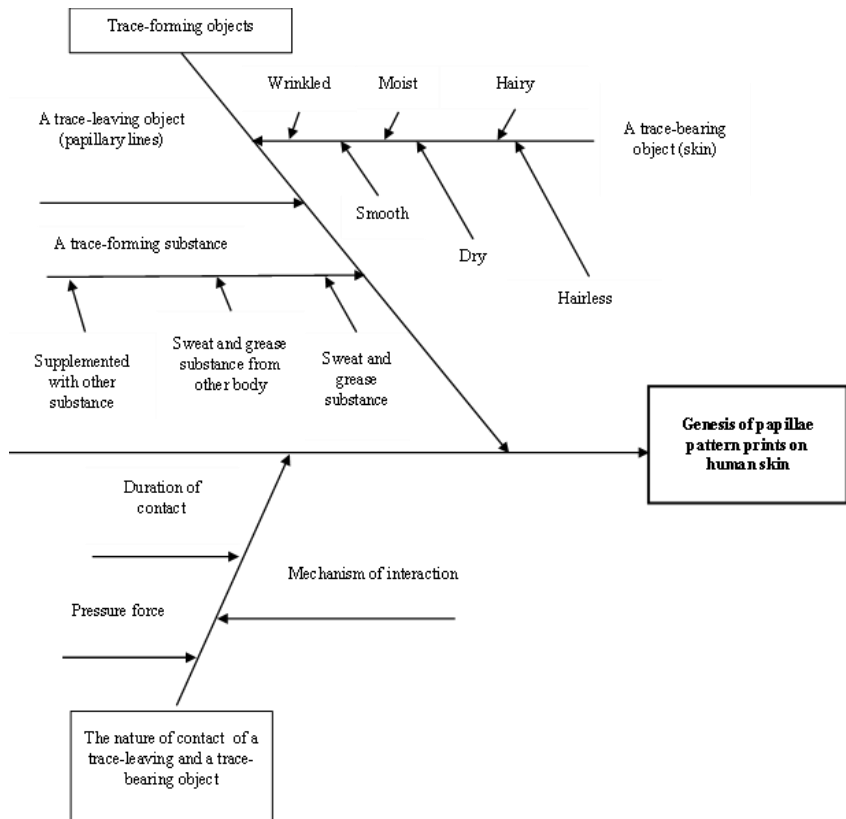


Figure 1.1 Factors affecting genesis of papillae pattern prints on human skin

Having studied and analysed the mechanism of formation of papillae pattern prints on human skin, it can be concluded that it is affected by several factors.

Firstly, they are a trace-forming object (papillary lines) and a trace-forming substance. The more pronounced the papillary lines and the more richly they are covered with sweat and grease substance (or some other substance),

the more likely it is that papillae pattern prints will be left on human skin.²⁷ When the pattern of papillary lines repeatedly comes into contact with a trace-bearing object, a layer of sweat and grease substance is layered, which cannot be regenerated with multiple layering at short intervals, causing depletion of sweat and grease substance, so the reflection of each subsequent trace will be weaker. On the other hand, if the contact point of the papillae pattern print is the same, then a layering of papillae pattern print is formed.

Secondly, it is the condition of a trace-bearing object (skin). If the skin is smooth and hairless, then it will better bear the papillae pattern print. However, this does not preclude the possible formation of papillae pattern prints on the skin with a small amount of hair and wrinkles.²⁸ If body hair at the point of contact is dense, then it forms an intermediate layer between a trace-leaving object (papillary lines) and a trace-bearing object (skin), which the papillary lines cannot penetrate due to their fine structure, thus making it difficult or impossible to reflect the pattern of the papillary lines at the point of contact. The condition of the skin also has to be understood as its elasticity, as the skin remains wrinkled when losing elasticity, but this could not significantly affect the reflection of a trace, because the relief of the papillary lines is rougher than the relief of the skin.

Thirdly, it is about the nature of the contact of a trace-forming object and a trace-bearing object. The mechanism of interaction between a trace-forming object and a trace-bearing object, which can be static or dynamic, is essential in the moment of trace formation.

At the time of formation of a static or pressure trace a trace-forming object and a trace-bearing object are in a relatively motionless position towards

²⁷ Lall, A., Zile, A. 2020. Phenomenon of Genesis of Papillae Pattern Prints on Human Skin. *RSU elektroniskais juridisko zinātnisko rakstu žurnāls Socrates*. 3(18). 56. doi.org/10.25143/socr.18.2020.3.049-058

²⁸ *Ibid.*

each other, for example, when strangling a victim who is in a helpless state or severely weaker physical condition in relation to the attacker.

On the other hand, dynamic traces are formed when both or one of a trace-forming objects is in a moving state relative to the other trace-forming object, for example, when grasping a forearm with insufficient pressure force, the contact area may be extended as a result of slipping.

At the moment of trace formation, the pressure force can affect the quality of the reflection of a trace, that is, the greater the pressure force applied at the moment of contact, the greater the possibility of deformation of the papillary lines. Under the influence of deformation caused by pressure, the papillary lines may widen and merge with each other, as a result of which a trace may be declared invalid for identification of a person.

The length of contact between a trace-leaving object and a trace-bearing object is affected by the activity to be performed and its purpose. For example, a dead body was moved with the aim of hiding the traces of a criminal offence and if it is moved by transfer, then the length of contact is affected by the weight of the body in relation to the physical condition of a mover or movers and the distance to be moved, during which several interceptions may be made at the place of contact or places. This was confirmed by carrying out an experiment simulating the movement of a dead body in Estonia. With multiple grips, as each subsequent trace is layering on the previous one, a layering of traces can be formed, which in turn can affect the reflection of the special features of the papillae pattern prints in order to recognize one of the layering of traces as valid for identification of a person.

2 Forensic aspects of retention and preservation of papillae pattern prints on human skin

From the moment papillae pattern prints are left, they are exposed to various external environmental factors that affect the retention of them. Taking into account the fact that papillae pattern prints can be found on different types of objects, the retention of them is not only influenced by external environmental factors, which affect their retention regardless of the object on which they were left, but also the changes of a trace-bearing object caused by the influence of external environmental factors.

During the period between the time of a criminal offence and the discovery of the body, we cannot influence the factors that affect the retention of traces, so the retention of traces is essential during this period.²⁹ To retain means to stay complete, intact, not to perish.³⁰

On the other hand, the preservation of papillae pattern prints begins with the examination of the scene and/or the place where the body was found and the examination of the corpse or the examination of the corpse at the location, during which one can ensure that papillae pattern prints on the corpse will not be damaged or destroyed until they are visualised, fixed and recovered. This is, of course, a relatively difficult task, because if papillae pattern prints are not visualised, fixed and recovered at the scene, then their preservation must be ensured during the examination of the corpse at the scene, during packing and transportation to the expert-examination institution, as well as during the period when the corpse is in the expert-examination institution until the traces are

²⁹ Zīle, A. 2021. Latentu papillārliņiju rakstu pēdu saglabāšanās un saglabāšana uz cilvēka ādas. *Starptautiskās zinātniskās konferences „Sociālās zinātnes reģionālajai attīstībai 2020”. II. Daļa. Valsts un tiesību aktuālās problēmas*. Daugavpils: Daugavpils Universitātes akadēmiskais apgāds „Saule”.67.

³⁰ Bāliņa, R. u.c. 2013.*Latviešu valodas vārdnīca*. Rīga: Avots. 935.

visualised, fixed and recovered.³¹ To preserve means to protect against destruction, deterioration.³²

In the specialised literature the term preservation of traces is used, however, according to the author, the terms retention and preservation should be separated, if only because the retention of traces is influenced by factors independent of us, while one can influence the preservation of traces by providing optimal conditions for their preservation.

2.1 Factors affecting retention of papillae pattern prints

Papillae pattern prints may be left on the corpse at the time of committing a criminal offence (mechanical asphyxia); after committing a criminal offence, committing the next criminal offence (necrophilia); hiding traces of a criminal offence (moving a corpse with the aim of hiding it), as well as a result of other human actions.

Initial and early signs of death do not in themselves affect the retention of papillae pattern prints on the skin, while the late signs of death may affect their retention, as they change the surface of the trace, as a result of which papillae pattern prints left on it may be damaged or destroyed.

The late signs of death are related to the decomposition of a corpse (i.e., destruction) or conservation under the influence of both internal and external factors. Intrinsic factors include tissue autolysis, which occurs through the release of enzymes in the tissue. External factors are related to the effects of bacteria and fungi, insects, animals, as well as environmental factors. The late signs of death can be manifested as putrefaction, mummification, wax,

³¹ Zīle, A. 2021. Latentu papillārliņiju rakstu pēdu saglabāšanās un saglabāšana uz cilvēka ādas. *Starptautiskās zinātniskās konferences „Sociālās zinātnes reģionālajai attīstībai 2020”. II. Daļa. Valsts un tiesību aktuālās problēmas*. Daugavpils: Daugavpils Universitātes akadēmiskais apgāds „Saule”.68.

³² Bāliņa, R. u.c. 2013. *Latviešu valodas vārdnīca*. Rīga: Avots. 935.

micellization (in peat) or preservation under the influence of chemical, thermal or other factors (salting, freezing, etc.).³³

The late signs of death are one of the factors that can significantly affect the retention of papillae pattern prints traces left during committing a criminal offense, as well as may create preconditions for leaving papillae pattern prints on the skin affected by the late signs of death. In addition to the effects of late signs of death, the retention of papillae pattern prints on the skin of a corpse is also influenced by factors affecting signs of death, such as time, environmental factors, biological factors, as well as post-mortem damage that can be caused by, for example, human exposure, which can be intentional to hide traces of a criminal offence or unintentional, for example, in an attempt to revive a person.

Similarly, leaving papillae pattern prints their natural aging process begins, which is affected by temperature and humidity.

In most cases papillae pattern prints are left on objects that are at ambient temperature, so the aging process of the traces is affected by the temperature of the surrounding environment and its fluctuations.

When assessing the influence of the environment and body temperature on the retention of papillae pattern prints, the following situations can be distinguished. First of all, at the moment of their interaction a trace-bearing object and a trace-receiving object had a similar temperature (36,6–36,9 °C), which can be both higher and lower than the temperature of the environment. Secondly, the temperature of a trace-bearing object is lower than the temperature of a trace-leaving object, but higher than +30 °C. Thirdly, the temperature of a trace-bearing object is lower than +30 °C.

While studying the factors affecting the retention of papillae pattern prints, the author developed the cause-and-effect diagram. (Figure 2.1)

³³ Teteris, O. 2004. *Tiesu medicīnas esence*. Rīga: Apgāds „Rasa ABC”. 97.

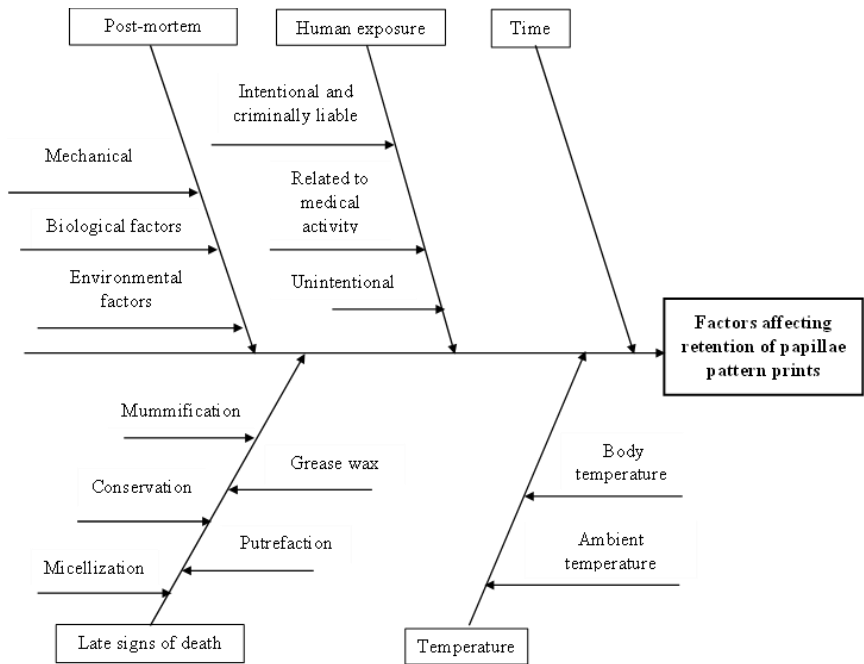


Figure 2.1 The cause-and-effect diagram of factors affecting retention of papillae pattern prints on skin of a deceased person

By studying and analysing the factors affecting retention of papillae pattern prints, it can be concluded that the possibility of retention of papillae pattern prints on the skin of a deceased person is affected by several factors, the effect of which can be both sequential and simultaneous, and one of the most important is time, because it creates preconditions for other factors affecting the traces. Therefore, retention of papillae pattern prints could be defined as an indefinite period of time between leaving the traces on an object and finding them on the object, during which the traces may be exposed to different influencing factors depending on the sequential and/or simultaneous exposure of a trace-bearing object and a trace-leaving object and other factors depending on

the location of an object and the environmental conditions.³⁴

2.2 Preconditions for preservation of papillae pattern prints

Preservation of papillae pattern prints on the skin of a deceased person begins at the same time as the inspection of the scene and the corpse. However, it should be noted that during the inspection of the scene and the corpse, papillae pattern prints on the skin of a deceased person are still exposed to retention factors that one cannot have impact on or prevent during the inspection of the scene and the corpse. Several authors have pointed out in their studies that the existence of papillae pattern prints on a victim's skin is very important evidence. However, their obtaining is only possible in rare cases. Latent papillae pattern prints on a victim's skin could be especially important in a situation where the place where the corpse was found is not the place where a criminal offence was committed and the corpse is found naked. Therefore, in situations where there might be a possibility of obtaining papillae pattern prints on a victim's skin, it is necessary to ensure their preservation, which can be affected by:

- 1) inspection of the scene and the corpse;
- 2) packaging for transporting the corpse;
- 3) environmental factors;
- 4) competence of an expert;
- 5) material and technical support.

During the dynamic inspection of the corpse attention should be paid to the naked parts of a victim's body and the possible location of latent papillae pattern prints should be localised, ensuring its inviolability during the dynamic

³⁴ Zīle, A. 2021. Latentu papillārlīniju rakstu pēdu saglabāšanās un saglabāšana uz cilvēka ādas. *Starptautiskās zinātniskās konferences „Sociālās zinātnes reģionālajai attīstībai 2020”. II. Daļa. Valsts un tiesību aktuālās problēmas*. Daugavpils: Daugavpils Universitātes akadēmiskais apgāds „Saule”.67.

inspection of the corpse. If the corpse has been moved and there is a possibility that the traces can be found in the area of the ankles and forearm wrists, then in order to preserve the under-nail substances, the packaging placed on the hands should be fastened in the area of the middle part of the hand, without touching the part of the wrist. On the other hand, when moving the corpse, it should not be grabbed by the areas localised. Similarly, a schematic representation of the human body should be added to the autopsy protocol with indications of those parts of the body and places where latent papillae pattern prints could have been left.

When making a decision to remove an object and send it for further study under laboratory conditions, it must be packed in such a way as not to damage or destroy the traces on an object, that is, to prevent contact between the surface of an object and the packaging material at the possible location of a trace on the corpse. To ensure this, the author offers a self-modelled construction that could limit the damage or destruction of papillae pattern prints on the skin of the corpse.

By studying retention and preservation of latent papillae pattern prints, it can be established that these concepts interact from the scene and the beginning of the inspection of the corpse to the packaging of the corpse, when the traces and the corpse are still in the external environmental conditions in which it was found, changing them only partially, for example, placing a canopy over the corpse, thus limiting the further effects of wind, rain and snow on retention and preservation of the traces. Of course, one cannot influence the effect of air temperature and humidity at the scene. It is also not recommended to rapidly change the environmental conditions, as this may jeopardize the preservation of the traces.

3 Analysis of technological solutions for visualisation of latent papillae pattern prints

Human skin is considered to be one the most complex trace-bearing surfaces on which latent papillae pattern prints can be visualised.

From the mid-1960s to the 1970s, when the possibilities of visualisation of latent papillae pattern prints on human skin began to be explored,³⁵ optical, physical and chemical methods of visualisation of papillae pattern prints, as well as various combinations of these methods, were used to find the most optimal method.

3.1 Dactyloscopic powders

One of the most commonly used physical methods of visualisation of latent papillae pattern prints is dusting with dactyloscopic powder. The oldest reference to this method in the special literature dates back to 1891.³⁶ This method is based on adhesion.

Adhesion (from Latin *adhaesio* – a sticking to) is molecular connection between the interfaces of two solids or liquids in contact.³⁷ Dactyloscopic powders contain two essential elements that ensure the adhesive properties of the powder, i.e., pigment and binder. The pigment provides the visualisation of a trace, while the binder provides adhesion between the powder and the trace-forming substance.³⁸

The application of dactyloscopic powders for visualisation of latent papillae pattern prints on the skin of a deceased person has been studied by

³⁵ Sampson, W. C., Sampson, K., L. 2005. Recovery of Latent Prints from Human Skin. *Journal of Forensic Identification*. 55(3). 362.

³⁶ Yamashita, B. et. al. 2011. *Chapter 7. Latent print development*. In: McRoberts, A. ed. The Fingerprint Sourcebook. 7-11. <https://www.ncjrs.gov/pdffiles1/nij/225320.pdf>

³⁷ Andersone, I. u. c. 2008. *Svešvārdu vārdnīca*. 16.

³⁸ Yamashita, B. et.al. 2011. *Chapter 7. Latent print development*. In: McRoberts, A. ed. The Fingerprint Sourcebook. 7-11. <https://www.ncjrs.gov/pdffiles1/nij/225320.pdf>

Straus J., Kropáček J., Dědičik F., Lenertz O., Schönborn S., Bohnert M. and others. The positive aspects of the application of this method are the variety of powders, their convenient use both at the scene and in the autopsy room. However, the opinions of various authors differ which of the dactyloscopic powders would be the most effective in visualisation of papillae pattern prints on the epidermis of a deceased person.

After visualisation of traces by using the detail photography technique, a trace is fixed to scale and only then they are transferred. This is necessary, because when transferring a trace, there is a risk that as a result of transferring it, it may not reflect a sufficient number of special features of the papillary line pattern, which creates an individual set of these features and provides the basis for recognition of a trace as valid for person identification. Dactyloscopic films or silicone paste are used to transfer traces visualised with dactyloscopic powder.

However, the white paste creates a greater contrast with the dark dactyloscopic powder, especially in situations where adhesion has been poor. Therefore, when choosing the material for transfer, one should take into account both the features of a trace-bearing surface and the properties of the duplicating material.

Dactyloscopic powders can be used for visualisation of papillae pattern prints, firstly, by dusting the surface of an object containing a trace with powder and, secondly, by applying the direct transfer method, which is based on transfer of latent papillae pattern print from the object to one of the lifting materials, onto which the copied latent trace is visualised with dactyloscopic powder.

3.2 Direct transfer method

The direct transfer method for recovery of latent papillae pattern prints was developed by Stone E.G. in 1977.³⁹

When using this method, the Kromekote card, paper, photo paper, etc. can be used as the material for lifting a trace. When lifting the trace, it should be taken into account that if the skin is warm, then the lifting material should be cooler, and if skin is cool, then a warmer lifting material should be used. The lifting material should be applied to the skin by pressing it with a uniform pressure force over the entire trace lifting area. A roller can be used to obtain a uniform pressure force. After that, the lifting material is carefully removed and placed at room temperature so that it is freed from moisture as it dries slightly. Afterwards, the traces are visualised with dactyloscopic powder.⁴⁰

William C. Sampson and Karen. L. Sampson pointed out the positive results of this method with practical examples.

On December 14, 1993, the body of a victim of a criminal offence was found in a cemetery in Greensboro, North Carolina, United States. Using warmed photo paper as a lifting material on a chilled body, a partial papillae pattern print of a palm was recovered from a victim's inner thigh. The photo paper with the trace lifted was then placed in a controlled warm environment and after 8 hours the lifted trace was visualised on it.⁴¹

A variety of lifting materials can be used for direct transfer method, depending on availability, such as plastic-coated paper, fixed and unfixed photo paper, exposed Polaroid paper, silver plate, plain paper, thermal paper.

³⁹ Reichard, G.J, Carr, J.C. and Stone, E.G. 1978. A Conventional Method for Lifting Latent Fingerprints from Human skin Surfaces. *Journal of Forensic Sciences*. 23(1). 135–141.

⁴⁰ Sampson, W. C., Sampson, K., L. 2005. Recovery of Latent Prints from Human Skin. *Journal of Forensic Identification*. 55 (3). 373–374.

⁴¹ *Ibid.*

Several risk factors that may affect a positive result should be considered when applying the direct transfer method. Firstly, this is the location and placement of latent traces or a latent trace to choose the most suitable and appropriately sized lifting material for the trace location on the body. Secondly, the temperature difference between the body and the lifting material, when a trace is on warm skin the temperature of the lifting material should be lower, but if a trace is on cold skin, then the temperature of the lifting material should be higher. Thirdly, the technique of applying the method, which requires skills, because the lifting material must be pressed against the surface of the skin on which a trace is located with a uniform force throughout the place and it must not be allowed to move either during its pressing or when lifting it with the trace lifted.

3.3 Iodine fuming

One of the methods of visualisation of papillae pattern prints is iodine fuming, which was described already in 1877.⁴² It is based on the absorption of iodine fumes by sebaceous material present on latent papillae pattern prints. Absorption (from Latin *absorptio* – a swallowing up) is a phenomenon where one substance (absorbent) absorbs another substance with its entire volume.⁴³

As a result of the reaction papillae pattern prints are coloured purple brownish,⁴⁴ brown.^{45,46} The peculiarity of the iodine fuming method is that traces become coloured for a short period of time, 10 to 15 minutes, after which traces

⁴² Eriksons, S. A., Risplings, U. 2000. *Identifikācijas pamati*. Rīga: Latvijas Policijas akadēmija. 84.

⁴³ Andersone, I. u. c. 2008. *Svešvārdu vārdnīca*. Rīga: Avots. 13.

⁴⁴ Indulēns, I. 1972. *Kriminālistiskā mācība par pēdām*. Rīga: Pētera Stučkas LVU redakcijas un izdevniecības daļa, 35.

⁴⁵ Eriksons, S. A., Risplings, U. 2000. *Identifikācijas pamati*. Rīga: Latvijas Policijas akadēmija. 84.

⁴⁶ Arājs, O. u. c. 2005. *Daktiloskopija*. Rīga: Latvijas Vēstnesis, 132.

remain colourless again and take their previous state before vaporization.⁴⁷ Iodine deposits on the fat, when exposed to air, changes to a gaseous state again, causing the prints to fade. If fingerprints are weak and development is stopped too early, the prints disappear quickly.⁴⁸

When studying the possibilities of application of iodine fuming method on human skin, it should be concluded that despite the indications about the toxicity of iodine in the experiments, the iodine fuming method was applied to both living and dead people.

The positive aspects of this method include:

- 1) possibility to visualise latent traces several times;
- 2) making several copies of traces;
- 3) succession of other visualisation methods, if no chemical reagents are used to fix the traces.

The negative aspects are:

- 1) iodine fumes are toxic and can cause health problems;
- 2) it is not recommended to use for fuming the skin of a living person;
- 3) repeated fuming increases air pollution;
- 4) temporary visualisation of traces fumed;
- 5) lifted traces will be “mirrored”;
- 6) fixing by photography the visualised traces requires good skills, but succession of visualisation methods of traces is possible. When using chemical reagents to fix a trace, the succession of visualisation methods is not possible.

Referring to the above, in order to ensure the application of the iodine fuming method, it is necessary to take precautions and apply this method in

⁴⁷ Indulēns, I. 1972. *Kriminālistiskā mācība par pēdām*. Rīga: Pētera Stučkas LVU redakcijas un izdevniecības daļa, 35.

⁴⁸ Eriksons, S. A., Risplings, U. 2000. *Identifikācijas pamati*. Rīga: Latvijas Policijas akadēmija. 85.

laboratory premises with a ventilation system and to use personal protective equipment.

3.4 Cyanoacrylate ester

The cyanoacrylate or “superglue” fuming method is also used to visualise latent papillae pattern prints on human skin.

In the 1950s, when developing an acrylic polymer for the aircraft industry, “superglue” (cyanoacrylate) was accidentally developed. At the end of the 1970s researchers in Japan and the United Kingdom almost simultaneously discovered the possibilities of fuming latent papillae pattern prints with cyanoacrylate fumes.⁴⁹

Cyanoacrylate esters (generally ethyl ester) is colourless liquid, known as “superglue”.⁵⁰ When the cyanoacrylate liquid is heated, vapours are produced, which react with the eccrine and sebaceous components of papillae pattern prints to form a white hard polymer.^{51,52}

When assessing the application of the cyanoacrylate fuming method for visualisation of latent papillae pattern prints, the positive aspects can be mentioned referring to the choice of different materials of cyanoacrylate (powder form, liquid form, Ciano Wand, plates, aerosol); selection of cyanoacrylate fuming chambers (portable and stationary); application at the scene and in the laboratory; polymerization of a trace, making it resistant to mechanical effects, which allows fuming of a trace at the scene, but their staining to increase contrast can be done under laboratory conditions.

⁴⁹ Yamashita, B. et. al. 2011. *Chapter 7. Latent print development*. In: McRoberts, A. ed. *The Fingerprint Sourcebook*. 7-23. <https://www.ncjrs.gov/pdffiles1/nij/225320.pdf>

⁵⁰ Arājs, O. u. c. 2005. *Daktiloskopija*. Rīga: Latvijas Vēstnesis, 138.

⁵¹ *Ibid*, 139.

⁵² Prakash, S. et.al. 2019. A Review on Recovery of Fingerprints From Epidermal Layer of Cadavers. *Journal of The Gujarat Research Societ.* 21 (13). 453–459. https://www.researchgate.net/publication/347992697_a_review_on_recovery_of_fing_erprints_from_epidermal_layer_of_cadavers

When applying cyanoacrylate fuming, one must work in a mask and protective glasses to avoid inhaling the fumes, which are toxic. During fuming, the vapor may not maintain the same vapor density, which may affect the visualisation of traces. It is necessary to increase the contrast of the visualised traces.

To increase the contrast of the fumed trace, a basic yellow solution (Basic Yellow 40), which fluoresces in blue light; red basic solution (Basic Red 14), which fluoresces in green light; Ardrex, whose fluorescence is caused by long UV radiation; Safranin O, which fluoresces in green light; Rhodamine 6G, which fluoresces in green light and the fluorescence is particularly strong; Sudan Black, which is a non-fluorescent dye in an ethanol/water mixture;⁵³ luminescent and non-luminescent dactyloscopic powders are applied.

In order to visualise latent papillae pattern prints on the skin of a deceased person by using the cyanoacrylate fuming method, it is possible to perform full or partial fuming of the corpse at the scene or in autopsy hall with good ventilation. However, the application of this method requires extensive material and technical support, as well as knowledge and skills in the selection of relevant materials. Of course, it is better to ensure a complete and uniform fumigation of the corpse, because when fuming the corpse in parts, there may be a situation when one of the traces is not visualised or a part of a trace is visualised.

⁵³ BVDA. Cyanoacrylate staining solutions. <https://www.bvda.com/en/cyano-staining-solution>

3.5 Ruthenium Tetroxide and Rhodamine 6G

Ruthenium tetroxide reacts with fatty oils, fats or protein-containing particles in the fingerprint producing brownish black image.⁵⁴ Visualisation of traces with ruthenium tetroxide can be done by spraying, fuming, or immersing an object in its solution⁵⁵ and it can be used to search for traces on the skin of the corpse by the iodine-silver plate method.⁵⁶

M. Trapecar and J. Balazic have also used ruthenium tetroxide (RTX) for visualisation of latent papillae pattern prints on the skin of a deceased person. When visualising traces with ruthenium tetroxide, 90 % of the traces left on the skin of a deceased person were visualised and partly recognised as valid for person identification. In most cases the distinctive features of the papillary line pattern were visible in the traces visualised with the potential to be used for person identification.⁵⁷

For their part, S. L. Fortunato and G. Walton used spraying of skin with Rhodamine 6G. However, this method was not recognised as practical for use at the scene.⁵⁸

Various methods and their combinations have been used in experiments to visualise latent papillae pattern prints on human skin. However, after studying and analysing the studies conducted and the results of experiments, it can be concluded that there are different opinions, because it is possible to visualise papillae pattern prints on the skin of a deceased person with different methods.

⁵⁴ Čentoricka, M.2002. *Pirkstu pēdu atklāšanas un izņemšanas līdzekļi un metodes*. Rīga: Latvijas Vēstnesis, 69.

⁵⁵ Centoricka, M., Rone, B., 2002. Development of Latent Fingerprints on Various Surfaces by Using the RTX Method. *Problems of Forensic Sciences* 51 (LD). 155–157.

⁵⁶ Čentoricka, M. 2002. *Pirkstu pēdu atklāšanas un izņemšanas līdzekļi un metodes*. Rīga: Latvijas Vēstnesis, 72.

⁵⁷ Trapecars, M., Balazics, J. 2007. Fingerprint recovery from human skin surfaces. *Science and Justice*. 47. 136–140. DOI: 10.1016/j.scijus.2007.01.002 https://www.academia.edu/16842525/Fingerprint_recovery_from_human_skin_surfaces

⁵⁸ Fortunato, S. L., Walton, G. 1998. Development of Latent Fingerprints from Skin. *Journal of Forensic Identification* 48 (6).704–715.

Several researchers, based on their own research and experiments conducted by other researchers, have compared the methods of visualisation of latent papillae pattern prints, as well as the materials used in the application of one method.

The different opinions of researchers can be explained by the difference in the initial data of the experiments, for example:

- 1) skin (both human and pig skin were used for the experiments);
- 2) condition of the skin (cleaned; uncleaned, condition of the skin after the occurrence of death);
- 3) the body of the deceased has been or has been not placed in a freezing chamber before or after leaving traces;
- 4) trace-forming substance (sweat and grease substance; sweat and grease substance supplemented from other parts of the body; sweat and grease substance supplemented with another substance, for example, oil);
- 5) duration of contact and pressure force during depositing traces;
- 6) the time period from the occurrence of death to the leaving of traces and to their visualisation;
- 7) the number of research objects (dead persons) used during the experiment and the number of traces left;
- 8) available material and technical base;
- 9) competence of experts in the application of methods.

A different approach was stated in the studies to the research object (corpse), using the whole body of the deceased, a severed part of the body or a piece of the skin for the experiment, according to the method chosen and the availability of the material and technical base.

The difference in the initial data indicated in the published studies has a significant impact on the correlation of the results of the studies conducted,

which, according to the author, makes it impossible to determine the advantages of one method over another.

4 An experiment on visualisation and recovery of latent papillae pattern prints from the epidermis of a deceased person

As part of the scientific work, the author independently conducted an experiment at the Thanatology Department of the State Forensic Science Bureau from June 1, 2017 to August 31, 2017 with the support of the State Police Forensic Service Department. Decision No. 6/27.04.2017 of the Rīga Stradiņš University Ethics Committee was received for conducting the experiment (Annex 1) and the permission of the State Forensic Science Bureau to conduct the experiment (letter No. 419-2017/Ļ 9-19 from May 23, 2017) (Annex 2). The research protocol complies with the ethical guidelines of Declaration of Helsinki 1964.

4.1 Materials and methods

In the framework of the experiment, 1419 latent papillae pattern prints were left on the skin of 43 dead persons. The study population consisted of 43 deceased persons, 33 of whom were men aged 25 to 81 years and 10 women aged 37 to 95 years.⁵⁹

Latent papillae pattern prints were visualised using dactyloscopic powders (adhesion agents) from BVDA (Holland): black non-magnetic powder (Special Blower Black B-35000), black non-magnetic powder (Concentrated Blower Black B-34500), black non-magnetic powder (Swedish Black B-421000), black non-magnetic powder (Black Special B-34000), black magnetic powder (Magnetic Jet Black B-45100), gray magnetic powder (Magnetic Gray B-46100).⁶⁰

⁵⁹ Zīle, A. 2017. Latentu papillārlīniju rakstu pēdu vizualizēšanas un izņemšanas iespējas no miruša cilvēka ādas. Eksperimentālās sērijas rezultāti. *Administratīvā un kriminālā justīcija*. 3 (80), 13. <http://journals.rta.lv/index.php/ACJ/article/view/2784/2751>

⁶⁰ *Ibid.*

Light dactyloscopic films were used as lifting agents for the traces visualised: Lifter (White) With Scale 143021 by Kjell Carlsson Innovation AB (Sweden), Lifter (White) With Scale 143023; dactyloscopic films Instant lifters White B-23600 by BVDA (Holland), Instant lifters White B-23700, tape for lifting microparticles Microtrace tape C-103505, Fingerprint Lifters White B-14000; Latent Print Tape 2"x 360" LP-200 by Remco company (the USA), Latent Print Tape 3"x 360" LP-300; Fingerprint Lifting Tape Transparent 2"x360" No.144L2 by Sirchie company (the USA), Lifting Tape Clear 2"x60" No.144L2RJ, light dactyloscopic film (Fingerprint lifter transparent) by FOMA (the Czech Republic) and White silicone with paste hardener C-1400 by BVDA (Holland).⁶¹

Latent papillae pattern prints were deposited onto such parts of the body: neck, shoulders, upper arm and forearm, thigh and shin, ankles, chest, abdomen and hips. The time of deposition of the prints varied from 24 to 96 hours after death occurred.⁶² Based on the results of earlier experiments, prints were deposited on parts of the body where there was little or no body hair, because hair creates an intermediate layer between the skin as a trace-bearing object and the papillary lines as a trace-leaving object.

In the course of the experiment two trace formation mechanisms were imitated – grip and pressure, the pressure force of which was variable, but the length of the contact was from 10 to 180 seconds.⁶³

A small-time interval was observed when leaving the prints to exclude sweat and grease depletion during their leaving. When leaving prints, they were also left on the part of the measuring line, with the aim of assessing the

⁶¹ Zīle, A. 2017. Latentu papillārlīniju rakstu pēdu vizualizēšanas un izņemšanas iespējas no miruša cilvēka ādas. Eksperimentālās sērijas rezultāti. *Administratīvā un kriminālā justīcija*.3 (80), 13. <http://journals.rta.lv/index.php/ACJ/article/view/2784/2751>

⁶² *Ibid.*

⁶³ *Ibid.*

sufficiency of the natural sweat and grease substance on the donor's hands at the moment of depositing prints.

With the aim of imitating natural latent papillae pattern prints on the skin of a deceased person, the necessary conditions regarding the skin condition of the deceased and the skin condition of the donor (trace leaver) were observed. Deposition of the prints on the skin of the deceased was performed before the autopsy and the skin condition was preserved as it was when the deceased was taken to the State Forensic Science Bureau. The skin of the donor on the palms and fingers throughout the experiment was not artificially protected, but exposed to the natural friction process as well as other types of exposure, such as exposure to household chemicals. During the process of the print formation, the palm and fingers of the donor were covered only with natural sweat and grease substance, without artificially supplementing it with sweat and grease substance from other parts of the donor's body, for example, forehead, neck. Compliance with these mentioned conditions ensured that trace formation was as close as possible to the natural conditions of their formation.

A number was assigned to each research object (corpse) and a protocol of the course of the experiment and the obtained results was filled in, in which the initial data and the results obtained during the experiment were recorded (Annex 3), as well as the protocol annex, in which the places of the body parts on which latent papillae pattern prints were left (Annex 4).

4.2 Results

The best adhesive properties were observed for Swedish Black, Black Special and Special Blower Black non-magnetic fine consistency dactyloscopic powders.

After visualisation of prints on the skin of a deceased person, it was found that the reflection of papillae pattern prints deposited under similar conditions

can be different, therefore, the prints could be divided into the following groups according to their reflection.

The prints, in which the papillary line pattern and the distinctive features of the papillary line pattern were clearly visible, were included in the first group. The second group included prints whose reflection partially showed a pattern of papillary lines and partially indicated contact. On the other hand, prints, which were reflected as a contact point, where the shape and arrangement of the fingers can be observed, but the pattern of papillary lines was not reflected, were included in the third group.

After visualisation and photographing papillae pattern prints, they were transferred onto one of twelve lifting agents.

A number of factors were taken into account when applying these lifting agents.

Firstly, the number of prints, their location and their relative placement. For example, when performing a forearm grip, both the palm and all five fingers or parts of the hand can be reflected. And taking into account that prints can be reflected both on the surface of the forearm and inside, it would be necessary to transfer these prints onto one lifting agent so that their reflection and mutual arrangement on the surface of a trace-bearing object is not lost during the transferring process. Secondly, the relief of a trace-bearing surface, so the skin condition (wrinkled or smooth) was taken into account. Thirdly, the part of the body and its position (flat, curved or concave). Fourthly, the ability of a lifting agent to capture the topography of the surface of trace-bearing object. Fifthly, the thickness of the dactyloscopic film and the adhesiveness of the emulsion layer.

Similarly, when visualising experimentally left latent papillae pattern prints with adhesion agents, a situation was stated when the prints were not coloured. In such situations the location of the experimentally left prints on the

body was photographed and transferred at the beginning of the experiment using various lifting agents, but during the course of the experiment, a decision was made to only photograph, which also explains the differences in the number of experimentally left and transferred prints.

When transferring the visualised prints, the properties and suitability of lifting agents for transfer of them from human skin were observed, which was also the basis for more frequent use of more appropriate lifting agents.

The best results were obtained by print transfer on the light dactyloscopic film Gelatin Lifters White and Latent Print Tape 3"x 360" LP-300, silicone paste White silicone with paste hardener.

After print visualisation and transfer, combinations of adhesive and lifting agents were identified that showed results in at least one of three groups:

- 1) the first group – traces are valid for person identification and can also be used to determine the mechanism of trace formation, if the size and location of traces allow it to be determined;
 - 2) the second group – traces are not valid for identification of a person, but can be used to determine the mechanism of trace formation, if the size and location of traces allow it to be determined. A person can be identified by a combination of the number of features visible on adjacent fingers of one hand. Taking into account the specificity of the trace-forming and trace-bearing object, this type of person identification could be more likely than the probability of a single trace identification;
 - 3) the third group – traces that are reflected as an indication of touch (contact) can also be used to determine the mechanism of trace formation, if the size and location of traces allow it to be determined.
- (Figure 4.1)

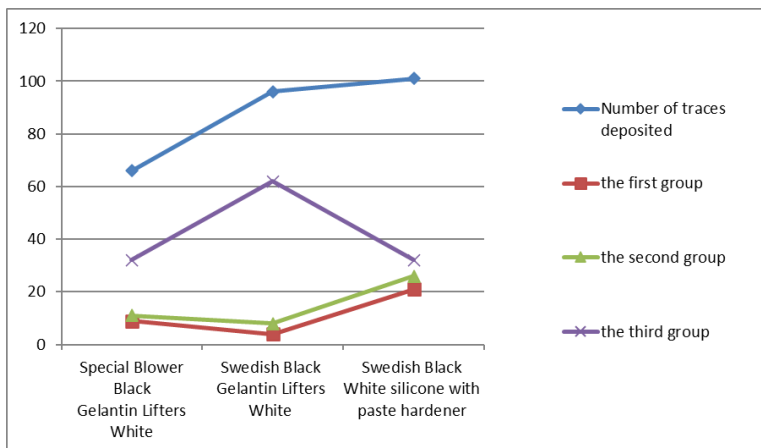


Figure 4.1 Graphical ratio between papillae pattern prints left and papillae pattern prints depending on the dominant combination of adhesive and lifting agents⁶⁴

By compiling the ratio of assessment of body parts and papillae pattern prints, it was found that papillae pattern prints valid for person identification were found on 12 out of 43 corpses, the number of traces not valid for person identification/elimination was found on 15 corpses, indication of touch/shape was found on 20 corpses, while no traces were found on 14 corpses. On 8 corpses papillae pattern prints valid for person identification, invalid traces, as well as an indication of touch/shape were found. On 4 corpses papillae pattern prints, both valid for person identification and invalid, were found. But on 2 corpses papillae pattern prints and an indication of touch/shape were found that were not valid for person identification. Similarly, during the experiment, 125 latent papillae pattern prints were left on the body parts of four corpses, their visualisation was performed after 24h, as a result, no traces were detected.

⁶⁴ Zīle, A. 2017. Latentu papillārlīniju rakstu pēdu vizualizēšanas un izņemšanas iespējas no miruša cilvēka ādas. Eksperimentālās sērijas rezultāti. Administratīvā un kriminālā justīcija 3 (80), 17. <http://journals.rta.lv/index.php/ACJ/article/view/2784/2751>

By compiling and analysing the ratio of gender, age, skin condition, duration of contact, and traces valid for person identification, it was stated that traces can be deposited and visualised not only on smooth skin, but also on wrinkled skin, as well as on skin with partial (sparse) hair. The skin, which was wet before depositing a trace, was dried by applying a paper towel and gently pressing it.

Similarly, no effect of gender and age on the ratio of traces valid for person identification was observed, as traces valid for person identification were found on 9 out of 33 male corpses and on 3 out of 10 female corpses, which proportionally make up one third of both the male and female population and at different ages in groups.

Based on the results of the experiment, the impact on a positive result was the length of contact between a trace-forming object and a trace-bearing object. At a contact duration of 120 s, 24 traces of papillae pattern prints valid for person identification were found in different age groups on the skin of both women and men.

In the course of the experiment a total of 1419 latent papillae pattern prints were deposited on the epidermis of 43 dead people, which were evaluated and divided into four categories after their visualisation and recovery:

- 37 papillae pattern prints were recognised as valid for person identification, because a sufficient number of special features of papillary line patterns were seen in them, which in turn create an individual set of these features;

- 66 papillae pattern prints reflected the papillary line pattern, but the special features of the papillary line pattern contained in them were not reflected in a sufficient quantity to recognize them as valid for person identification;

- in 202 papillae pattern prints the shape of the finger phalanges and palm was reflected, but the pattern of papillary lines was not reflected, indicating touch;

- 1114 experimentally left traces were not visible.⁶⁵

As a result of the experiment:

- 1) deliberate dominant adhesive agents are Swedish Black, Black Special and Special Blower Black and dominant lifting agents are dactyloscopic films Gelantin Lifters White and Latent Print Tape 3"x 360" LP-300, as well as silicone paste White silicone with paste hardener. The combinations of dominant visualisation and lifting agents were also identified, and namely, Special Blower Black and Gelantin Lifters White, Swedish Black and Gelantin Lifters White, Swedish Black and White silicone with paste hardener;⁶⁶
- 2) the possible reflection of papillae pattern prints on the skin of a deceased person was stated;
- 3) it was established that papillae pattern prints can be deposited and visualised not only on smooth but also on wrinkled skin;
- 4) conscious parts of the body on which it is more possible to visualise and recover papillae pattern prints valid for person identification;⁶⁷
- 5) the optimal duration of contact between a trace-forming and a trace-bearing object has been determined;
- 6) no influence of gender and age of a victim on formation, visualisation and recovery of traces was observed.

⁶⁵ Zīle, A. 2017. Latentu papillārlīniju rakstu pēdu vizualizēšanas un izņemšanas iespējas no miruša cilvēka ādas. Eksperimentālās sērijas rezultāti. *Administratīvā un kriminālā justīcija*. 3 (80), 18 – 19. <http://journals.rta.lv/index.php/ACJ/article/view/2784/2751>

⁶⁶ *Ibid*, 19.

⁶⁷ *Ibid*.

4.3 Discussion

In order to obtain as objective an opinion as possible and with the aim of approbation of the method used in the experiments, the initial data and results of four experiments were correlated. For a clearer structure of the study, the experiments are numbered according to the time of their implementation.

Experiment No. 1

In the time period from April 2000 to May 2001, the Federal Criminal Police Office in Wiesbaden and the Institute of Forensic Medicine in Freiburg conducted the experiment “Dactyloscopic traces on human skin”.⁶⁸

Experiment No.2

In the time period from November 2006 to November 2008 in the framework of the project AGIS JLS/2006/AGIS/042(30-CE-0080807/00-07) the experiment “Latent fingerprints and DNA on human skin” was carried out.⁶⁹

Experiment No 3

In the time period from October 2010 to June 2008 in the framework of the project ISEC JLS / 2009 / ISEC / AG / 184 the experiment “Optimisation of recovery of human latent fingerprints and DNA on Human Skin” was carried out.⁷⁰

⁶⁸ Lenertz, O., Schönborn, S. and Bohnert, M. 2002. Daktyloskopische Spuren auf menschlicher Haut – Ergebnisse einer praxisorientierten Versuchreihe. *Archiv für Kriminologie*. 210. 130

⁶⁹ AGIS Project – Final Report JLS/2006/AGIS/042(30 – CE – 0080807/00 – 07). 2009. Latent Fingerprints and DNA on Human Skin. Bundeskriminalamt (German Federal Criminal Police) Central Services Division, ZD 31 – Crime Scene Unit, Weisbaden. 5.

⁷⁰ Final Report ISEC Project JLS/2009/ISEC/AG/184. 2014. Optimisation of Recovery of Latent Fingerprints and DNA on Human Skin. Bundeskriminalamt (German Federal Criminal Police) Central Services Division, ZD 31 – Crime Scene Unit, Weisbaden. 2.

Experiment No.4

In the time period from June 2017 to August 2017 the experiment “Possibilities of recovery and visualisation of latent papillae pattern prints from the skin of a dead person. Results of a series of experiments” was conducted. The author carried out a series of experiments in cooperation with the State Police Forensic Service Department and the State Forensic Science Bureau.⁷¹

The analysis of the initial data, results and observations of the experiments allows to conclude that the chosen physical method, using dactyloscopic powders for visualisation of latent papillae pattern prints on the skin of a deceased person, is the most optimal method, the application of which does not affect the complex study of the corpse, and no additional material and technical base is required.

However, taking into account the fact that even after the conducted research and the approbation of the method in many countries where the study and the method were approved, it is not applied in practice due to the low results, because visualisation of traces on other objects gives much better results, even though the traces are on the corpse epidermis is a direct indication of contact and therefore essential evidence.

The approbation of the method by carrying out experiments in the Czech Republic, Germany, Denmark, the United Kingdom, Austria, Estonia, Latvia and other countries allows to conclude that the method should be implemented in practice by applying it by an expert (criminologist) or a forensic medicine expert, since experts as well as forensic experts from both forensic services have participated in the research.

⁷¹ Zile, A. 2017. Latentu papillārlīniju rakstu pēdu vizualizēšanas un izņemšanas iespējas no miruša cilvēka ādas. Eksperimentālās sērijas rezultāti. *Administratīvā un kriminālā justīcija*. 3. 13.

4.4 Legal framework of methods applied in forensic expert-examination and its development

Based on the findings gained in the course of the study about the corpse as a research object, expanding the amount of evidence obtained on it, performing the visualisation of latent papillae pattern prints on the epidermis of the corpse and being aware of the troublesome conditions that can significantly affect the process and result of visualisation and recovery, according to the author, visualisation of latent papillae pattern prints on the epidermis of the corpse using dactyloscopic powders should be distributed as a separate method.

Therefore, the author proposes to make amendments to the Register of Methods of Forensic Expert-examination by including the “Dactyloscopic powder method for visualisation of papillae pattern prints on the epidermis of a deceased person”.

And equally in accordance with Section 18, First paragraph, Clause 1 of Law on Forensic Experts, “ shall approve training programmes in the specialties of forensic experts, and also organise certification and recertification”, to make amendments in the training programme of forensic expert candidates with specialty code 08.02., approved on March 26, 2012 at the meeting of the Council of Forensic Experts No.50, in the specialty “Visualisation of papillae pattern prints” by excluding from point 3 subsection 3.5 and expressing paragraph 4 in the following wording “*4. Research objects:*

- 4.1 objects with an absorbent surface;*
- 4.2 objects with a non-absorbent surface;*
- 4.3 objects with a sticky surface;*
- 4.4 objects with a clean and dirty surface;*
- 4.5 objects with bloody traces;*
- 4.6. human skin as a trace-bearing object”.*

Taking into account that the examination of a corpse is complicated and the influence of time on the retention of papillae pattern prints is of great importance, then in practice, when processing a corpse with dactyloscopic powder, with the aim of visualising possible papillae pattern prints on it, it would be recommended that an expert obtain a certificate for both in visualisation of papillae pattern prints, but also in dactyloscopic identification, in order to make a decision as soon as possible about the validity of traces for person identification, in order to be able to recover other possible traces on the corpse and perform an autopsy of the corpse. In such a case based on Sections 198 and 199 of Criminal Procedure Law, expert commissions and complex forensic expert-examination will be determined.

In the author's opinion, the visualisation of latent papillae pattern prints on the epidermis of the corpse should be performed by the same expert who participated in the inspection of the scene, because it is not necessary to get acquainted with the case materials, which will significantly reduce the time from inspection of the scene and the corpse at the scene to visualisation of traces and exclude the possibility of placing the corpse in a freezer before trace visualisation.

Conclusions

The aim of the Thesis was achieved by fulfilling the tasks set and providing answers to the research questions. In the course of the study, the theoretical and practical aspects of visualisation of latent papillae pattern prints on the epidermis of a deceased person were identified. As a result of the study, the author drew the following conclusions, which affect the theoretical, practical and legal aspects of cognition, and divided them into three groups.

The first group contains conclusions and proposals on the genesis of papillae pattern prints, their reflection, and factors affecting retention and preservation of papillae pattern prints on human epidermis.

1. With the development of possibilities of human identification dactyloscopy has not lost its role in the detection of criminal offences and in person identification. Its development trends are focused on the development of new and innovative methods and the improvement of existing methods by recognizing new trace-bearing surfaces, for example, the epidermis of a deceased person.
2. All three trace-forming objects in trasology are involved in the genesis of papillae pattern prints on human skin: a trace-leaving object (papillary lines on palm and fingers); a trace-bearing object (human skin on any part of the body); trace substance (sweat and grease substance; sweat and grease substance supplemented with another substance).
3. During formation of papillae pattern prints on human epidermis, as a result of mutual interaction between a trace-leaving object and a trace-bearing object, the natural composition of a trace-forming substance is composed of apocrine or merocrine sweat gland sebum, sebaceous gland secretion and dead skin cells, which may also contain other

substance impurities after contact of the surface of a trace-leaving object or a trace-bearing object with some other object or substance.

4. During the process of trace formation, changes occur on the surface of a trace-bearing object, traces are divided into superficial (layering, delamination) and three-dimensional traces (volumetric). Three-dimensional traces on human skin are of theoretical importance, because their retention is affected by the pressure force applied during the mechanism of trace formation, the roughness of papillae pattern prints, and their temporary retention.
5. Trace reflection is divided into three groups according to visibility: visible, poorly visible or latent (invisible), however, in practice, the author has identified cases when these three trace groups form different combinations of them. Therefore, the author offers the following subgroups of trace classification by visibility:
 - 1) one part of the trace can be visible, and the other – poorly visible;
 - 2) one part of the trace can be visible, and the other – latent;
 - 3) one part of the trace can be poorly visible, and the other – latent;
 - 4) one part of the trace can be visible, the other – poorly visible, and the third – latent.

Trace combinations can significantly affect the choice of visualisation method of traces, as well as the visualisation result.

6. The following factors affect the genesis of papillae pattern prints on human epidermis:
 - 1) trace forming objects:
 - A a trace-leaving object (papillary lines);
 - B a trace-bearing object (skin) – smooth, wrinkled, dry, wet, hairless, hairy;

- C a trace-forming substance – sweat and grease substance, sweat and grease from other parts of the body, supplemented with another substance.
- 2) the nature of the contact between a trace-leaving object and a trace-bearing object:
- A duration of contact;
 - B pressure force;
 - C mechanism of interaction.
7. After depositing papillae pattern prints on the epidermis of a deceased person, the natural aging of the traces begins, the effect of post-mortem changes of the corpse and, depending on the location of the corpse, the influence of various external environmental factors. From the commission of a criminal offence to the detection of a corpse, one cannot influence the factors affecting papillae pattern prints, which is why the ability of the traces to be retained until the beginning of inspection of the scene and the corpse is essential, when the factors acting on traces can be partially affected by preservation of traces until they are visualised. Therefore, the author distinguishes two periods of time – the retention of traces and the preservation of traces, providing a definition of these terms:
1. Retention of papillae pattern prints is the period of time from depositing traces during or after the commission of a criminal offence until the detection of a corpse, when the papillae pattern prints on the epidermis of a corpse are affected by various external factors. Factors affecting trace retention are:
- A time;
 - B human exposure:
 - a) intentional and criminally liable;

- b) related to medical activity;
 - c) unintentional.
 - C post-mortem damage:
 - a) mechanical factors;
 - b) biological factors;
 - c) environmental factors.
 - D late signs of death:
 - a) micellization;
 - b) putrefaction;
 - c) conservation;
 - d) wax;
 - e) mummification.
 - E temperature:
 - a) ambient temperature;
 - b) body temperature.
2. Preservation of papillae pattern prints is the period of time from the scene and/or the place where a corpse was found and the inspection of the corpse or examination of the corpse at the location, during which conditions are ensured so that the traces on the corpse are not damaged or destroyed, until they are visualised, fixed and recovered. Factors affecting the preservation of papillae pattern prints on the epidermis of a deceased person are:
- A environmental factors;
 - B inspection of the scene and the body;
 - C an expert's competence;
 - D packaging of the corpse;
 - E material and technical support.

8. To pack a corpse, with the aim of ensuring partial non-contact of the research object (corpse) and the packaging material, ensuring the localisation of possible papillae pattern prints on the epidermis of the corpse, the author offers a self-modelled construction. The construction consists of six “square bracket” type polymer material parts with fasteners at both ends, which can be attached to the side edges of the stretcher; frame covering rectangular polyethylene material with cut-outs in the corners, on the edges of which zippers are attached, which, when pulled, secure the construction.

Conclusions and proposals on technological solutions for visualisation of latent papillae pattern on human epidermis, results of an experiment performed by the author, correlation of initial data and results of four experiments performed in Germany, Denmark, United Kingdom, Austria, Estonia and Latvia are included in the second group.

9. There is a wide range of methods for visualisation of papillae pattern prints. However, the following visualisation methods are most often used to visualise them on the epidermis of a deceased person in studies with the aim of finding the most optimal method:
 1. The wide application of the dactyloscopic powder method can be explained by its simplicity and wide application possibilities, ensuring the visualisation of traces on various surfaces, including human epidermis. It is based on the adhesive properties of the powder, which are provided by the two components contained in the powder: the pigment that ensures the colouring of a trace and the binder that forms the adhesion between the powder and a trace-forming substance. Visualisation of traces on the research object provides the opportunity to cover a large surface with dactyloscopic powder, as a result of which a reflection of the trace

location and their mutual location is obtained, which allows conclusions to be drawn about the mechanism of trace formation.

2. The direct transfer method is based on the transfer of a latent papillae pattern print on the lifting material, which after transfer is visualised using dactyloscopic powder. A wide range of lifting materials is available for the application of this method, which makes it possible to choose the most optimal lifting material for each specific situation. To apply the method, firstly, it is necessary to respect the temperature differences of the body and the material to be transferred; secondly, the technique of its application requires good practical skills; thirdly, the transferred trace is obtained as “mirrored”.
3. The iodine fuming method is based on the absorption of iodine fumes by the fatty substances present in papillae pattern prints, as a result of which the traces are coloured for a short time, as they change to a gaseous state again when exposed to air. Photography can be used to fix the visualised traces, or traces can be lifted and then fixed using different fixing methods. The positive aspects of this method are multiple visualisations of a trace; obtaining multiple copies of a trace; if no chemical reagents are used to fix the traces, then the succession of other visualisation methods is possible. When using the iodine fuming method, it should be taken into account that iodine vapours are toxic; re-fuming increases air pollution; temporary visibility of traces fumed; lifted traces will be mirrored; good practical skills are required for the fixation of the visualised traces when photographing.
4. When the cyanoacrylate ester is heated, vapours are produced, which react with the merocrine components of sweat and

sebaceous glands present in a trace-forming substance and turn it white when polymerised. To increase the contrast of the visualised traces one shall apply chemical reagents or luminescent and non-luminescent dactyloscopic powders. The application of the method requires appropriate material and technical support; personal protective equipment as the vapours are toxic. The method can be applied both at the scene and in the laboratory. When fuming traces at the scene, the vapor may not maintain the same density, affecting the visualisation process.

5. Ruthenium tetroxide can be used as an independent reagent for visualisation of traces, as well as by the iodine fuming method. When reacting with fat, oil or protein-containing particles in the trace substance, the trace is coloured brownish black. Ruthenium tetroxide can be applied by steaming or spraying skin to visualise papillae pattern prints on the epidermis of a deceased person.
 6. After application of Rhodamine 6G, the skin should be rinsed with methanol to visualise a trace. After the skin has dried, using the green laser light Rhodamine 6G produces a very strong fluorescence. Due to the technological application of the method, it is not recommended to apply it at the scene.
10. In the framework of the Thesis the author independently conducted an experiment at the Thanatology Department of the State Forensic Science Bureau with the support of the State Police Forensic Service Department. The following results were obtained:
1. By visualisation of latent papillae pattern prints on the epidermis of a deceased person, the dominant adhesive agents were determined:
A *Swedish Black*;

- B *Black Special*;
 - C *Special Blower Black*.
2. When lifting the visualised papillae pattern prints, the dominant lifting agents were stated:
- A *Gelatin Lifters White*;
 - B *White silicone with paste hardener*;
 - C *Latent Print Tape 3"x 360"*.
3. Dominant combinations of adhesive agents and lifting agents were determined based on the distribution of papillae pattern prints into one of the groups:
- A the first group – traces are valid for person identification and can also be used to determine the mechanism of trace formation, if the size and location of traces allow it to be determined;
 - B the second group – traces are not valid for identification of a person, but can be used to determine the mechanism of trace formation, if the size and location of traces allow it to be determined. A person can be identified by a combination of the number of features visible on adjacent fingers of one hand. Taking into account the specificity of the trace-forming and trace-bearing object, this type of person identification could be more likely than the probability of a single trace identification;
 - C the third group – traces that are reflected as an indication of touch (contact) can also be used to determine the mechanism of trace formation, if the size and location of traces allow it to be determined.
4. Dominant adhesive agents and lifting agents are:
- A *Swedish Black* and *White silicone with paste hardener*;

- B *Swedish Black* and *Gelantin Lifters White*;
- C *Special Blower Black* un *Gelantin Lifters White*.

5. By visualisation of traces, it was stated that the reflection of traces left in similar conditions can be different. Classification of traces according to their reflection is:
 - A clearly visible papillary line pattern in a trace and the special features of the papillary line pattern in it;
 - B in the reflection of a trace papillary line pattern is partially visible and there is an indication of contact;
 - C traces were reflected as a contact point, where the shape and arrangement of the fingers can be observed, but papillary line pattern is not reflected.
6. The visualised traces were evaluated and assigned to one of four evaluation categories:
 - A valid for person identification;
 - B not valid for person identification/elimination;
 - C indication of touch/shape;
 - D traces were not detected.
7. During the experiment, it was found that papillae pattern prints valid for person identification were found on 12 out of 43 corpses, the number of traces not valid for person identification/elimination was found on 15 corpses, indication of touch/shape was found on 20 corpses, while no traces were found on 14 corpses. On 8 corpses papillae pattern prints valid for person identification, invalid traces, as well as an indication of touch/shape were found. On 4 corpses papillae pattern prints, both valid for person identification and invalid, were found. But on 2 corpses papillae pattern prints and an indication of touch/shape were found that were not valid

for person identification. Similarly, during the experiment, 125 latent papillae pattern prints were left on the body parts of four corpses, their visualisation was performed after 24h, as a result, no traces were detected.

8. During the experiment the parts of the body on which traces were found were identified, which could be assigned to one of the evaluation categories of papillae pattern prints, distinguishing the three parts of the body on which the largest number of traces was visualised:
 - A traces valid for person identification – 18 traces were visualised on the right and left sides of the chest; 6 on the knee of the right and left leg; 3 on the right and left upper arm;
 - B traces not valid for person identification/elimination – 36 traces were visualised on the right and left side of the chest; 6 on the right and left side of the abdomen; 5 on the thigh of the right and left leg;
 - C indication of touch/shape – 38 traces were visualised on the right and left sides of the chest; 33 on the thigh of the right and left leg; 27 on the right and left side of the abdomen.
9. By compiling and analysing the ratio of gender, age, skin condition, duration of contact, and traces valid for person identification, it was stated that traces can be deposited and visualised not only on smooth skin, but also on wrinkled skin, as well as on skin with partial (sparse) hair.
10. Similarly, no effect of gender and age on the ratio of traces valid for person identification was observed, as traces valid for person identification were found on 9 out of 33 male corpses and on 3 out of 10 female corpses, which proportionally make up one third of

both the male and female population and at different ages in groups.

11. Based on the results of the experiment, the impact on a positive result was the length of contact between a trace-forming object and a trace-bearing object. At a contact duration of 120 s, 24 traces of papillae pattern prints valid for person identification were found in different age groups on the skin of both women and men.
12. During the experiment a total of 1419 latent papillae pattern prints were deposited on the epidermis of 43 dead people. The following results were obtained after their visualisation, recovery and evaluation:
 - A a sufficient number of special features of papillary line patterns, which in turn create an individual set of these features, was seen in 37 papillae pattern prints and it enabled to recognize them as valid for person identification;
 - B in 66 papillae pattern prints the special features of the papillary line pattern were not reflected in a sufficient quantity and, thus, they were recognised as not valid for person identification (limitation / elimination);
 - C in 202 papillae pattern prints the shape of the finger phalanges and palm was visible, but the pattern of papillary lines was not reflected. That made it possible to classify these traces in the category – indication of touch;
 - D 1114 experimentally left traces, however, were not visible, so they were divided in the category – no traces.

11. To approbate of the method, a correlation of the initial data and results of four experiments conducted in Germany, Denmark, the United Kingdom, Austria, Estonia and Latvia it was stated:

- 1) one of the factors that can influence the number of papillae pattern prints valid for person identification is the condition of the skin of the corpse and the part of the body on which the traces were deposited;
- 2) factors such as trace-forming object, trace-forming substance, the mechanism of trace formation, the pressure force of depositing traces, and of course the duration of contact between a trace-forming object and a trace-bearing object also play an important role in the process of trace formation;
- 3) different types of adhesive agents and lifting agents were used in all experiments for visualisation and transfer of traces in order to experimentally determine which of adhesive agents and lifting agents is the most suitable for visualisation and recovery of traces. Despite the fact that the opinions were slightly different, it was concluded that the chosen physical method, using dactyloscopic powders for trace visualisation can be approved for the visualisation latent papillae pattern prints on the skin of a deceased person;
- 4) the ratio of papillae pattern prints valid for person identification to the number of traces left allowed to conclude that by supplementing the naturally present sweat and grease substance of a trace-leaving object with sweat and grease substance from other parts of the body or with another substance, such as hand cream, dactyloscopic powders are enhanced adhesive properties.

12. The analysis of the initial data, results and observations of the experiments allows to conclude that the chosen physical method, using dactyloscopic powders for visualisation of latent papillae pattern prints on the skin of a deceased person, is the most optimal method, the application of which does not affect the complex study of the corpse, and no additional material and technical base is required.

The third group includes conclusions and proposals of a legal nature on the visualisation of latent papillae pattern prints on epidermis of a deceased person.

13. Based on the findings gained in the course of the study about the corpse as a research object, expanding the amount of evidence obtained on it, performing the visualisation of latent papillae pattern prints on the epidermis of the corpse and being aware of the troublesome conditions that can significantly affect the process and result of visualisation and recovery, according to the author, visualisation of latent papillae pattern prints on the epidermis of the corpse using dactyloscopic powders should be distributed as a separate method. Therefore, the author proposes to make amendments to the Register of Methods of Forensic Expert-examination by including the “Dactyloscopic powder method for visualisation of papillae pattern prints on the epidermis of a deceased person”.

14. And equally making amendments in the training programme of forensic expert candidates with specialty code 08.02., approved on March 26, 2012 at the meeting of the Council of Forensic Experts No.50, in the specialty “Visualisation of papillae pattern prints” by excluding from Clause 3 subsection 3.5 and expressing paragraph 4 in the following wording “4. Research objects:

4.1 objects with an absorbent surface;

- 4.2 *objects with a non-absorbent surface;*
- 4.3 *objects with a sticky surface;*
- 4.4 *objects with a clean and dirty surface;*
- 4.5 *objects with bloody traces;*
- 4.6 *human skin as a trace-bearing object”.*

15. In Section 5, the third part of Law on Forensic Experts Law there is an unequal treatment of the procedure for registering the method, because the institution in which a state forensic expert works submits the method only for registration in the Council of Forensic Experts, and the private forensic expert – for approval and registration in the Council of Forensic Experts. In order to prevent the unequal method approval procedure in the Council of Forensic Experts, amendments should be made to Section 5, the third part of Law on Forensic Experts Law, expressing them in the following wording: *“The method prepared for the performance of a forensic expert-examination shall be submitted by a private forensic expert and the institution in which a state forensic expert is employed for approval and registration to the Council of Forensic Experts.”*

List of publications and reports on the topic of the Thesis

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Annexes

Decision of the Ethics Committee of Rīga Stradiņš University

Veidlapa Nr. E-9 (2)

RSU ĒTIKAS KOMITEJAS LĒMUMS NR. 6 / 27.04.2017.

Rīga, Dzirciema iela 16, LV-1007
Tel. 67061596

Komitejas sastāvs	Kvalifikācija	Nodarbošanās
1. Profesors Olafs Brīvers	Dr.theo.	teologs
2. Professore Vija Sīle	Dr.phil.	filozofs
3. Asoc.prof. Santa Purviņa	Dr.med.	farmakologs
4. Asoc.prof. Voldemārs Arnis	Dr.biol.	rehabilitologs
5. Professore Regīna Kleina	Dr.med.	patalogs
6. Profesors Guntars Pupelis	Dr.med.	ķirurgs
7. Asoc.prof. Viesturs Līguts	Dr.med.	toksikologs
8. Docente Iveta Jankovska	Dr.med.	
9. Docents Kristaps Cīrensis	Dr.med.	

Pieteikuma iesniedzējs: Aelita Zīle
Juridiskā fakultāte, doktorantūra

Pētījuma nosaukums: „ Kriminālistiskās metodikas modernizācijas virzieni. Uz liķa konstatējamo papillārlīniju rakstu pēdu atrašanas, vizualizēšanas, fiksēšanas un izņemšanas gadījumu analīzes piemēri”

Iesniegšanas datums: 19.04.2017.

Pētījuma protokols: Izskatot augstāk minētā pētījuma pieteikuma materiālus (protokolu) ir redzams, ka pētījuma mērķis tiek sasniegts veicot uz vīriešu un sievietu liķiem atstātās eksperimentālās papillārlīniju rakstu pēdu uz dažādām ķermeņa vietām, ar dažādu pēdu veidošanas mehānismu, kontakta ilgumu un pēdu saglabāšanās ilgumu detalizētu eksperimentu Valsts tiesu medicīnas ekspertīžu centrā, iegūto datu apstrādi, analīzi, kā arī izsakot priekšlikumus. Tiek ievērota izpētes objektu personas datu aizsardzība. Līdz ar to pieteikums atbilst pētījuma ētikas prasībām.

Izskaidrošanas formulārs: nav nepieciešams

Piekrīšana piedalīties pētījumā: nav nepieciešama

Komitejas lēmums: piekrist pētījumam

Komitejas priekšsēdētājs Olafs Brīvers Tituls: Dr. miss., prof.

Paraksts

Ētikas komitejas sēdes datums: 27.04.2017.



The response of the State Forensic Medicine Expertise Centre to the application



Valsts tiesu medicīnas ekspertīzes centrs

Hipokrāta iela 2/8-6, Rīga, LV-1038, tālrunis: 67536138, fakss: 67536136, e-pasts: vtmecc@vtmecc.gov.lv, www.vtmecc.gov.lv

Rīgā

23. OS. 2017 Nr. 449-2017 | 29-19

Uz 22.02.2017. Nr. b/n

Aelītai Zīlei
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Par atbildi uz iesniegumu

Valsts tiesu medicīnas ekspertīzes centrs (turpmāk – centrs) 16.05.2017. ir saņēmis un ir iepazīies ar Jūsu 22.02.2017. iesniegumu, kurā lūdzat centra un Zinātniski metodiskās padomes priekšsēdētāja, asoc. profesora O.Tetera atbalstu promocijas darba “Kriminālistiskās metodikas modernizācijas virzieni. Uz liķa konstatējamo papillārlīniju rakstu pēdu atrašanas, vizualizēšanas, fiksēšanas un izņemšanas gadījumu analīzes piemēri” eksperimentālās sērijas veikšanai.

Centrs neiebilst promocijas darba izstrādes ietvaros eksperimentālās sērijas veikšanai (atbilstoši Jūsu pievienotajam aprakstam, bez miruši cilvēka audu un orgānu ieguves) centra Tanatoloģijas nodaļā ar nosacījumu, ka tās norise notiks asoc. profesora O.Tetera vai cita Tanatoloģijas nodaļas vadītāja norīkota tiesu medicīnas eksperta uzraudzībā, saskaņā ar likuma “Par miruša cilvēka ķermeņa aizsardzību un cilvēka audu un orgānu izmantošanu medicīnā” prasībām, bez piekļuves mirušo personu sensitīvajiem datiem un to tālākas izmantošanas iespējām, kā arī bez piekļuves ekspertīzē iegūtajai informācijai.

Direktors

Egils Harasimjūks

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VTMECC-VD-AD-17
Redakcija: 10.06.01.2017.

Protocol of the course of the experiment and the obtained results
Compilation of the initial data and results of the four experiments

Initial data and results	Experiment			
	Experiment No. 1 ⁷²	Experiment No. 2 ^{73,74}	Experiment No. 3 ⁷⁵	Experiment No. 4 ⁷⁶
Number of dead persons	20	40	50	43
Gender of dead persons Woman/man	10/10	22/18	not specified	10/33
Aged of dead persons	from 3 months - 86 years	from 15–98 years	not specified	from 25–95 years
Ambient temperature at which the corpses were stored	27 C°	17–25C°	not specified	not measured
Temperature of the skin of a corpse	was not lower than 25C°	13–25C°	not specified	not measured
Skin condition of the corpse	dry, smooth, intact skin surface	dry, smooth, intact skin surface	dry, with minimal hair	dry, smooth, intact skin surface

⁷² Lenertz, O., Schönborn, S., Bohnert, M. 2002. „Daktyloskopische Spuren auf menschlicher Haut – Ergebnisse einer praxisorientierten Versuchreihe“. *Archiv für Kriminologie*.210:129–138.

⁷³ AGIS Project – Final Report JLS/2006/AGIS/042(30 – CE – 0080807/00 – 07). 2009. Latent Fingerprints and DNA on Human Skin. Bundeskriminalamt (German Federal Criminal Police) Central Services Division, ZD 31 – Crime Scene Unit, Weisbaden. 1–40.

⁷⁴ Färber D., Seul A., Weisser H.J., Bohnert M. 2010. Recovery of Latent Fingerprints and DNA on Human Skin. *Journal of Forensic Sciences*. 55. 1457–1461.

⁷⁵ Final Report ISEC Project JLS/2009/ISEC/AG/184. 2014. Optimisation of Recovery of Latent Fingerprints and DNA on Human Skin. Bundeskriminalamt (German Federal Criminal Police) Central Services Division, ZD 31 – Crime Scene Unit, Weisbaden. 1–40.

⁷⁶ Zile, A. 2017. Latentu papillārīniju rakstu pēdu vizualizēšanas un izņemšanas iespējas no miruša cilvēka ādas. Eksperimentālās sērijas rezultāti. *Administratīvā un kriminālā justīcija*. 3.12–23.

Post-mortem period, in which latent papillae pattern prints were deposited on the corpse	6–96 h	24–240 h	not indicated	24–96 h
Location of latent papillae pattern prints on the corpse	head, forehead, neck, chest, shoulders, lower leg, foot joint, foot area	foot, lower leg, upper leg, forearm, upper arm	ankle, forearm, wrist, lower leg	neck, shoulders, upper arm, lower arm, thigh, lower leg, ankle area, chest, abdomen, hips
Trace-formation mechanism	push (pressure), grip	push (pressure), grip	push (pressure), grip	push (pressure), grip
Duration of contact of a trace-leaving object and a trace-bearing object	not measured	Some seconds	Some seconds, grip at least 20 sec	10 – 180 sec
Pressure force	not measured, but classified as mild, medium, severe	not measured, designated as strong	not measured, but designated as medium	was not measured, variable
A trace-forming substance	hand sweat and grease substance, supplemented from the forehead and withers, supplemented with extraneous grease (creme)	supplemented from the forehead and throat	hand sweat and grease substance, supplemented by sweating induced by additional activities (jogging, stair climbing), rubbing the hands, sweat and grease substance was distributed evenly	hand sweat and grease substance, not supplemented

Temperature of a trace leaver (donor)	not measured, but higher than the corpse t°	not measured, but higher than the corpse t°	not measured, but higher than the corpse t°	not measured, but higher than the corpse t°	
Time of beginning of trace visualisation after depositing them	after 12 h	30–60 min	~ 60 min	10 min–3h 50min	
Number of traces deposited	486	1000	Part 1 – 1000	Part 2 – 1200	1419
Papillae pattern prints valid for person identification	59	before trace transferring – 91, after trace transferring – 65	30	48	37
Number of traces with papillary line pattern visible	91	before trace transferring – 69, after trace transferring – 56	69	81	66
Number of traces with indication of touch (a trace shape is visible)	336	before trace transferring – 338, after trace transferring – 284	901	86	202
No result (a trace shape is not visible)		before trace transferring – 502, after trace transferring – 545		985	
Adhesive agents	black magnetic powder, black non-magnetic powder	black magnetic powder, black non-magnetic powder	black magnetic powder (Black Magnetic Powder), black non-magnetic	black magnetic powder (Special Blower Black), black non-magnetic	

			powder (Black Powder), green magnetic fluorescent powder (Fluorescent Magnetic Powder), disposable black powder	powder (Concentrated Blower Black), black non-magnetic powder (Swedish Black), black non-magnetic powder (Black Special), black magnetic powder (Magnetic Jet Black), gray magnetic powder (Magnetic Gray)
Brushes	magnetic brush, Marabou brush	magnetic brush, disposable fibreglass brush	magnetic brush, disposable fibreglass brush	magnetic brush, Marabou brush
Lifting agents	Transparent fingerprint lifting tape, white gelatine lifter, ISOMARK white silicone paste	ISOMARK dispensing gun, cartridge (white silicone paste) and nozzles, white gelatine film	not used	light dactyloscopic films: Lifter (White) With Scale, Instant lifters White, Fingerprint Lifters White, Latent Print Tape 2"x 360", Latent Print Tape 3"x 360", Fingerprint Lifting Tape Transparent 2"x360",

				Lifting Tape Clear 2"x60", light dactyloscopic film (Fingerprint lifter transparent), silicone paste white (White silicone with paste hardener), film for lifting microparticles Microtrace tape
Photographing	performed after trace visualisation and after transferring	performed after trace visualisation and after transferring	performed after trace visualisation	performed after trace visualisation and after transferring