Aelita Zile
PhD in Social Sciences,
Assistant Professor, Faculty of Social Sciences,
Rīga Stradiņš University
https://orcid.org/0000-0002-4378-738X

Līze Feldmane
Inspector criminalist,
Zemgale Expert Unit of the Regional Bureau of the Forensics Department
of the Central Criminal Police Department of the State Police

METEOROLOGICAL CONDITIONS AS ONE OF THE EXTERNAL FACTORS INFLUENCING THE RETENTION OF PAPILLAE PATTERN PRINTS

Meteorological conditions are one of the external factors that, under certain conditions, directly have an impact on the retention of papillae pattern prints. An experiment was conducted to investigate how meteorological conditions affect the retention of papillae pattern prints on different surfaces over a long period of time. The experiment resulted in empirical data confirming the retention of papillae pattern prints valid for personal identification on wood, metal, plastic and glass surfaces over a period of ten days.
Keywords: papillae pattern prints, retention of traces, meteorological conditions.

Problem statement. Papillae pattern prints can be found on the surfaces of various objects at a crime scene, both indoors and outdoors. Depending on the location of the object, a number of factors, such as time, deliberate or accidental human activity, and meteorological conditions, have an impact on the retention of traces. It should also be taken into account that traces can be found on easily movable, hard-to-move and non-movable objects. One of the challenges when conducting the inspection of a crime scene is the presence of hard-to-move and non-moveable objects on which papillae pattern prints are exposed to meteorological conditions even during the inspection.

Objective of the article. The aim of the study was to investigate and analyse the effect of meteorological conditions on the papillae pattern prints left on the surfaces of wood, plastic, metal and glass objects. The experiment was carried out between October 6, 2024, and October 16, 2024 by exposing the papillae pattern prints experimentally left on objects to meteorological conditions.

Analysis of recent research and publications. The retention of papillae pattern prints under the influence of various external factors is of great importance, as in practice, there is a risk of physical evidence being damaged or destroyed, for example, by burning or submerging in water. Therefore, the retention of papillae pattern prints on different surfaces and under different external conditions has

been studied by researchers in many countries. The results of experiments have confirmed that papillae pattern prints valid for personal identification can be retained at both low [13] and high temperatures [5; 1]; on objects immersed in standing and flowing spring water [8], water supply system water [10; 14], lake and rain water [4], fresh and salt water [2; 9], muddy water [11], and the effect of immersion time on traces has been studied [6; 7]. The effect of humidity has also been studied [12]; the effect of temperature and humidity in an attempt to determine the age of the trace [3].

Presentation of the main material. 10 painted wooden boards, 10 plastic 1.5 litre bottles, 10 painted metal plates, 10 glass 0.5 litre jars were selected for the experiment. On each of the objects nine latent papillae pattern prints were deposited with natural sweat and grease substance, without supplementing it with sweat and grease substance from other parts of the body, such as the forehead, neck, by simulating the trace-forming mechanism of pressure. A five-minute interval was observed to avoid depletion of the sweat and grease substance during leaving a trace. A total of 360 traces were left on 40 objects.

After deposition of traces, the objects were placed in an open area where the experimentally placed traces were exposed to the meteorological weather conditions present at the time of the experiment, as reflected in Table 1.

Every 24 hours, four objects (one wooden board, one plastic bottle, one metal plate, one glass jar) were brought into a room with a temperature of 22°C. The natural drying time of the objects ranged from 1.5 to 2.5 hours. After drying, the latent papillae pattern prints left on the objects were visualised with BVDA dactyloscopic powders

Table 1

Description of weather conditions for the period from October 6, 2024, to October 16, 2024

Date	Meteorological elements				Description of weather conditions
	Air t° at night	Air t° during the day	Air t° difference	Wind speed	
06/10/2024	4 ℃	9° C	5 ℃	1 m/s at night, 1 m/s in gusts 2 m/s during the day, 3 m/s in gusts	Clear weather
07/10/2024	3 ℃	10 ℃	5 ℃	1 m/s at night, 1 m/s in gusts 1 m/s during the day, 2 m/s in gusts	Overcast, sometimes with clear spells
08/10/2024	6 ℃	12 ℃	6 ℃	2 m/s at night, 2 m/s in gusts 3 m/s during the day, 6 m/s in gusts	Clear weather
09/10/2024	10 ℃	12 ℃	2 ℃	4 m/s at night, 6 m/s in gusts 6 m/s during the day, 12 m/s in gusts	Overcast, intermittent rain
10/10/2024	13 ℃	15 ℃	2 ℃	3 m/s at night, 6 m/s in gusts 6 m/s during the day, 11 m/s in gusts	Cloudy, sometimes with clear spells
11/10/2024	15 ℃	13 ℃	2 ℃	4 m/s at night, 7 m/s in gusts 5 m/s during the day, 9 m/s in gusts	Overcast, rainy
12/10/2024	8 ℃	12 ℃	4 ℃	2 m/s at night, 6 m/s in gusts 4 m/s during the day, 7 m/s in gusts	Cloudy, sometimes with clear spells
13/10/2024	4 ℃	9 ℃	5 ℃	2 m/s at night, 3 m/s in gusts 3 m/s during the day, 6 m/s in gusts	Cloudy, sometimes with clear spells
14/10/2024	7 ℃	8 ℃	1 ℃	2 m/s at night, 5 m/s in gusts 1 m/s during the day, 3 m/s in gusts	Overcast
15/10/2024	7 ℃	11 ℃	4 ℃	2 m/s at night, 4 m/s in gusts 4 m/s during the day, 8 m/s in gusts	Cloudy
16/10/2024	5 ℃	10 ℃	5 ℃	3 m/s at night, 6 m/s in gusts 2 m/s during the day, 5 m/s in gusts	Clear weather

(the Netherlands): black non-magnetic powder (Instant Black B-39000), black non-magnetic powder (Special Black B-34000), black non-magnetic powder (Swedish Black B-421000). For dusting the traces, a carbon fibre brush (Carbon fibre brush B-58000), a Marabou brush with black feathers (Marabou brush with black feathers B-57100), a carbon zephyr brush (Zephyr brush B-55000) produced by BVDA (the Netherlands) were used. The visualised traces were lifted with white silicone paste MIKROSIL (MCM100) combined with hardener (MCM100CA Catalyst).

Before visualising the experimentally left traces, the surfaces of the objects were examined under combined lighting (daylight and artificial light) using a pocket torch at a slanted angle.

The papillae pattern prints visualised with adhesive agents and transferred onto white silicone paste were divided into four groups:

A – papillae pattern prints valid for personal identification (distinct features of 12 or more papillary lines reflected in the trace);

B – papillae pattern prints invalid for personal identification (less than 12 distinct features of papillary lines reflected in the trace);

C – indication of touch/shape;

D – no indication of touch/ the trace left is not visible.

The classification of the visualised and transferred traces for each object can be seen in Tables 2, 3, 4, and 5.

Table 2

Classification of adhesive agents used for visualisation of latent papillae pattern prints and of prints visualised on the wooden objects

Adhesive agent	Number of visualised papillae pattern prints according to the classification			
	A	B	C	D
Instant Black B-39000	21	6	3	0
Special Black B-34000	0	14	12	4
Swedish Black B-421000	9	15	3	3
In total	30	35	18	7

Table 3

Classification of adhesive agents used for visualisation of latent papillae pattern prints and of prints visualised on the plastic objects

Adhesive agent	Number of visualised papillae pattern prints according to the classification			
	A	B	C	D
Instant Black B-39000	8	6	8	8
Special Black B-34000	5	3	9	13
Swedish Black B-421000	3	9	7	11
In total	16	18	24	32

Table 4

Classification of adhesive agents used for visualisation of latent papillae pattern prints and of prints visualised on metal objects

Adhesive agent	Number of visualised papillae pattern prints according to the classification			
	A	B	C	D
Instant Black B-39000	8	6	1	15
Special Black B-34000	5	8	2	15
Swedish Black B-421000	19	7	1	3
In total	32	21	4	33

Table 5

Classification of adhesive agents used for visualisation of latent papillae pattern prints and of prints visualised on glass objects

Adhesive agent	Number of visualised papillae pattern prints according to the classification			
	A	B	C	D
Instant Black B-39000	16	9	1	4
Special Black B-34000	22	7	1	0
Swedish Black B-421000	18	8	1	3
In total	46	34	3	7

The evaluation of the adhesive agents used to visualise the experimental papillae pattern prints and the classification of the traces into groups shows that dactyloscopic powders have showed good results for all objects. However, evaluating the obtained results, the time during which the traces left on the object were exposed

to meteorological conditions must also be taken into account. Therefore, during the experiment, the ratio of the traces visualised on wooden, plastic, metal and glass objects after 24 h, 48 h, 72 h, 96 h, 120 h, 144 h, 168 h, 192 h, 216 h and 240 h was collected and analysed and presented in Tables 6, 7, 8 and 9.

Based on the results obtained during the experiment it can be concluded that it is possible to visualise papillae pattern prints on wooden, plastic, metal and glass objects after 24 h, 48 h, 72 h, 96 h, 120 h, 144 h, 168 h, 192 h, 216 h and 240 h of exposure to meteorological conditions.

The data presented in Tables 6, 7, 8 and 9 indicate that the period of time during which an object has been exposed to meteorological conditions is not always a determining factor in whether the traces have been damaged or destroyed. For

Table 6

Evaluation ratio of the visualised papillae pattern prints on wooden objects after 24 h, 48 h, 72 h, 96 h, 120 h, 144 h, 168 h, 192 h, 216 h, and 240 h

Evaluation of papillae pattern prints	Detection time of latent papillae pattern prints under the influence of meteorological conditions									
	24 h	48 h	72 h	96 h	120 h	144 h	168 h	192 h	216 h	240 h
A	6	1	3	4	5	1	3	0	6	1
B	3	1	0	4	4	4	3	6	3	7
C	0	7	0	1	0	4	3	2	0	1
D	0	0	6	0	0	0	0	1	0	0

Table 7

Evaluation ratio of the visualised papillae pattern prints on plastic objects after 24 h, 48 h, 72 h, 96 h, 120 h, 144 h, 168 h, 192 h, 216 h, and 240 h

Evaluation of papillae pattern prints	Detection time of latent papillae pattern prints under the influence of meteorological conditions									
	24 h	48 h	72 h	96 h	120 h	144 h	168 h	192 h	216 h	240 h
A	3	6	1	0	1	0	3	1	0	1
B	6	2	1	0	1	0	2	4	1	1
C	0	1	2	0	7	7	2	1	3	1
D	0	0	5	9	0	2	2	3	5	6

Table 8

Evaluation ratio of the visualised papillae pattern prints on metal objects after 24 h, 48 h, 72 h, 96 h, 120 h, 144 h, 168 h, 192 h, 216 h, and 240 h

Evaluation of papillae pattern prints	Detection time of latent papillae pattern prints under the influence of meteorological conditions									
	24 h	48 h	72 h	96 h	120 h	144 h	168 h	192 h	216 h	240 h
A	7	6	2	0	7	3	2	0	1	4
B	2	1	1	3	2	6	1	0	1	4
C	0	2	0	0	0	0	0	0	1	1
D	0	0	6	6	0	0	6	9	6	0

Table 9

Evaluation ratio of the visualised papillae pattern prints on glass objects after 24 h, 48 h, 72 h, 96 h, 120 h, 144 h, 168 h, 192 h, 216 h, and 240 h

Evaluation of papillae pattern prints	Detection time of latent papillae pattern prints under the influence of meteorological conditions									
	24 h	48 h	72 h	96 h	120 h	144 h	168 h	192 h	216 h	240 h
A	9	7	7	0	4	5	4	6	7	7
B	0	2	1	2	4	3	5	3	2	2
C	0	0	1	1	1	0	0	0	0	0
D	0	0	0	6	0	1	0	0	0	0

example, after 72 hours, only 3 out of 9 papillae pattern prints valid for personal identification were found on the surface of the wood (distinct features of 12 or more papillary lines reflected in the trace), whereas after 216 hours, 6 out of 9 papillae pattern prints valid for personal identification were found. When examining the traces recovered from the plastic material, it is evident that after 96 hours there was no indication of touch on the surface or the trace left was not visible, but after 168 hours it was possible to detect 3 of the 9 papillae pattern prints valid for personal identification. Similarly, on metal material, after 96 hours, no indication of touch was detected or the trace left was not visible, but on the final day, after 240 hours, 4 out of 9 papillae pattern prints valid for personal identification were detected. Similarly, on

Table 10

Papillae pattern prints deemed valid for personal identification after being exposed to meteorological conditions on objects for 24 h, 48 h, 72 h
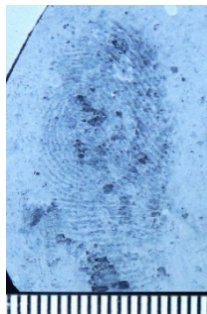
Object	Presence of latent papillae pattern prints under the influence of meteorological conditions		
	24 h	48 h	72 h
Wood			
Plastics			No traces valid for personal identification were found.
Metal			
Glass			

Table 11

Papillae pattern prints deemed valid for personal identification after being exposed
to meteorological conditions on objects for 96 h, 120 h, 144 h

Object	Presence of latent papillae pattern prints under the influence of meteorological conditions		
	96 h	120 h	144 h
Wood			No traces valid for personal identification were found.
Plastics	No traces valid for personal identification were found.		No traces valid for personal identification were found.
Metal	No traces valid for personal identification were found.		
Glass	No traces valid for personal identification were found.		

the glass material, after 96 hours, no indication of touch was detected or trace left was not visible on the surface, but after 240 hours, 7 out of 9 papillae pattern prints valid for personal identification were detected.
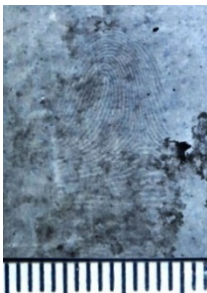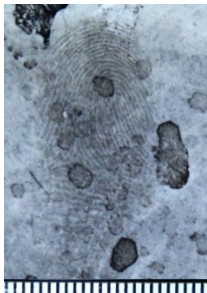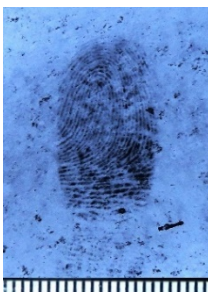
The photographs of the papillae pattern prints on objects deemed valid for valid for personal identification under the influence of meteorological conditions are presented in Tables 10, 11, 12, and 13.

During the experiment, the air temperature fluctuated between 8°C to 15°C during the day, but at night it ranged from 3°C to 15°C. The highest temperature fluctuations

Table 12

Papillae pattern prints deemed valid for personal identification after being exposed
to meteorological conditions on objects for 168 h, 192 h, 216 h

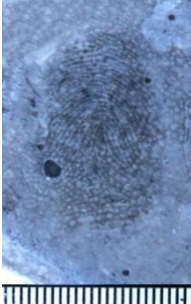| Object	Presence of latent papillae pattern prints under the influence of meteorological conditions		
	168 h	192 h	216 h
Wood			
Plastics		No traces valid for personal identification were found.	No traces valid for personal identification were found.
Metal		No traces valid for personal identification were found.	
Glass			

were observed on October 6, 7, 8, 13 and 16, when the temperature varied from 5°C to 7°C, while the lowest temperature variations were observed on October 9, 10, 11 and 14, when the temperature varied from 1°C to 2°C. From October 9 to 11, a constant 2°C temperature fluctuation was observed for 3 consecutive days.

Summarizing and analysing the results obtained during the experiment, the effect of wind and wind gusts on the retention of papillae pattern prints was also studied and analysed. During the experiment, the wind speed ranged from 1 m/s to 6 m/s, but in gusts, it reached up to 12 m/s. The highest wind speeds were observed on October 9, 10, 11, and 12, when the wind speed varied from 4 m/s to 6 m/s, with gusts ranging from 7 m/s to 12 m/s, while the smallest wind fluctuations

Table 13

**Papillae pattern prints deemed valid for personal identification after being exposed
to meteorological conditions on objects for 240 h**

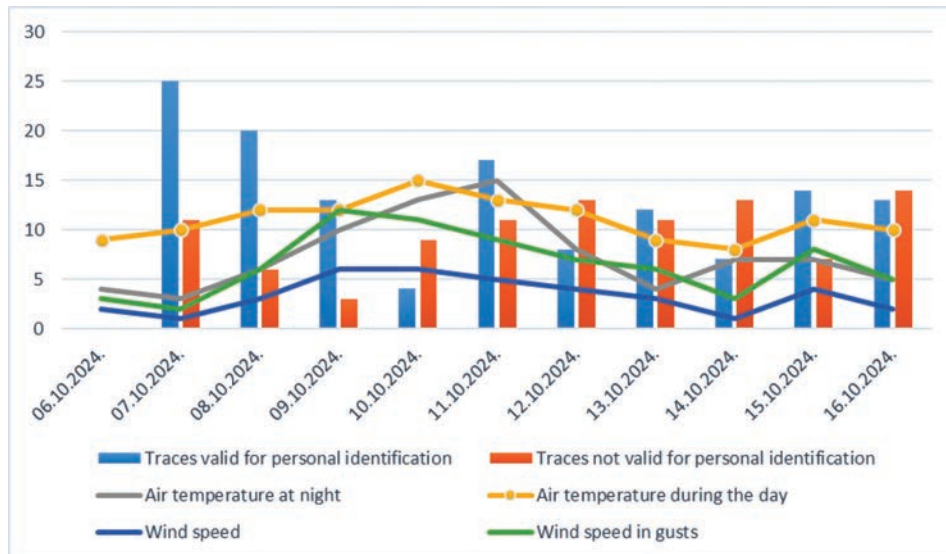| Object	Presence of latent papillae pattern prints under the influence of meteorological conditions	
	240 h	
Wood		
Metal		
Plastics		
Glass		

**Chart 1. Graphical relationship between valid and invalid for personal identification
papillae pattern prints, wind speed fluctuations and temperature fluctuations on
wooden, plastic, metal and glass objects**

were observed on October 6, 7, and 14, when the wind speed ranged from 1 m/s to 2 m/s, with gusts from 2 m/s to 3 m/s.

By summarising the results obtained during the experiment, dividing the experimentally deposited and visualised papillae pattern prints into four groups, recording the air temperature and its fluctuations, wind speed and wind gusts during the experiment, Chart 1 was created, illustrating the relationship between the results obtained and the meteorological conditions.

The graph shows that during the period when the daily and nightly air temperature fluctuations

are small and there is no significant difference between wind speed and wind gusts, their impact on the retention of traces is minimal. This leads to the conclusion that it is the range of temperatures and wind speeds that has the greatest effect on the retention of traces.

Conclusions. It was found during the experiment that:

1) Papillae pattern prints valid for personal identification left on wooden, plastic, metal and glass objects can be visualised after 24 h, 48 h, 72 h, 96 h, 120 h, 144 h, 168 h, 192 h, 216 h and 240 h;

2) The retention of papillae pattern prints is more influenced by the fluctuations in daytime and night-time temperatures, as well as wind speed and gusts. The greater the fluctuations, the greater the impact on retention of traces;

3) However, other biological aspects should also be taken into account, such as the intensity of sweat and grease substance production, the effect of depletion of sweat and grease substance on trace formation, gender, age, and other biological aspects that could affect trace formation and retention under meteorological conditions.

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Аеліта Зіле, Лізе Фельдмане. Метеорологічні умови як один із зовнішніх факторів, що впливають на збереження відбитків папілярних візерунків
Метеорологічні умови є одним із зовнішніх факторів, які за певних умов безпосередньо впливають на збереження відбитків папілярних візерунків. Було проведено експеримент, щоб дослідити, як метеорологічні умови впливають на збереження відбитків папілярних візерунків на різних поверхнях протягом тривалого періоду часу. В результаті експерименту були отримані емпіричні дані, що підтверджують збереження відбитків папілярних візерунків, придатних для ідентифікації особи, на дерев'яних, металевих, пластикових і скляних поверхнях протягом десяти днів.
Ключові слова: папілярні візерунки відбитків, збереження слідів, метеорологічні умови.