VICTORIA POLICE

VICTORIA FORENSIC SCIENCE CENTRE

FINGERPRINT BRANCH

MODULE NINE

LATENT FINGERPRINT COMPOSITION

FPB TRAINING
24/06/2002

LATENT PRINT COMPOSITION

Locard's Law of Contact
A latent print is a (chance) contact impression of friction ridge skin.

In the late 1920's, the eminent French scientist, Professor LOCARD, propounded the following physics "Law of Contact": -

"When two objects come into contact, there is always a transfer of material from each object to the other. Often, this transfer is obvious, at least in one direction, but even when the amount of material transferred, or its nature is such that nothing is visible, there is always some transfer".

This is the law of nature that applies to the leaving of latent prints.

Generally, a latent print is the material transferred from the friction ridge skin to a surface that comes in contact with it and/or the transfer of matter to the friction ridge skin from the contact surface.

This law does not mean that all friction ridge contact can be detected and it is a popular Misconception that a person's print can be detected every time he touches something. There is always a transfer of material but in order that it be detected, it is necessary that: -

1. Sufficient matter be transferred on contact so that it is visible or it can be made visible by available methods.

2. The duration of the components of latent matter can vary, but its life is usually limited.

3. The contact surface must be such that it does not dissipate or destroy the transferred material.

Latent Prints

Detectable latent prints can generally be grouped as follows: -

1. Visible

Those composed of paint, Blood, ink, dirt, etc.

2. Invisible prints

Those composed of normal friction skin surface matter (referred to as true latents) or foreign matter from other contact sources, eg. food, grease, hair oil, motor oil, etc., often present in significant quantities; all of which require developing to be seen.

3. Moulded Prints

Impressions of ridged skin in soft substances, eg. putty, dust, grease, wax, etc.

4. Etched Prints

Impressions of ridged skin eroded into metals by the corrosive compounds of skin surface matter.

The composition of most of the substances aforementioned is generally of only passing interest or significance to those engaged in fingerprint work but an understanding of the true latent skin surface matter is essential as latent prints formed by this substance probably compose a large percentage of those detected. Also, they are the least understood.

The Skin

The skin is the largest organ of the human body. It is comprised of two main layers; the dermis and the epidermis. The dermis is the underlayer and is composed of fibrous connective tissue. The epidermis is the outer section and is a many layered sheet of cells. The outer two thirds of the epidermis is composed entirely of dead, scale like cells, which constantly slough off from the surface. The cells originate from the base of the epidermis, actively divide and regenerate and migrate gradually to the surface. On their migration, the cells accumulate within them a protein substance called 'Keratin'. The sloughing off of dead cells is termed 'Keratinisation'.

The Glands

Located in the dermis and the underlying fatty tissue are glands which excrete matter through ducts to the surface of the epidermis. This excretion serves many purposes: -

(a) A means of ridding the body of wastes.

(b) "Lubricating" and keeping the skin in good condition.

(c) Washing away dead cells.

(d) Coating the skin with a water repellent shield.

(e) Acting as one of the body's cooling systems.

(f) Improving the traction of ridged skin.

The activity of these glands is controlled by the nervous system and the glands function continuously, even when the body is completely at rest or asleep. "Insensible" or "passive" perspiration (Eccrine gland excretion) may amount to 600 to 700 millimetres per day.

Eccrine Glands

The perspiration (eccrine or exocrine gland excretion) rate is increased by physical activity, emotional stress, fear, mental excitement, environmental temperature and medical stimulation. Environmental temperature of 31`c - 32`c (88`-90`F) will produce visible perspiration.

The glands in the palms and soles respond very slowly and weakly to thermal stimulation, but respond first and immediately to mental stimulation; the latter reaction probably is a significant factor in leaving latent impressions during the commission of a crime.

Perspiration accounts for 5% to 51% of fluids lost from the body and from 1% to 25% of total body fluid turnover.

There is an average of well over 2,000,000 perspiration glands in the body. Their density and the rate of their excretions change from one part of the body to another and varies from person to person. The excretion's composition is influenced by sex, age, body and mental health, diet, the body's metabolism and the activity of the body.

Most of the body skin, until about middle age, is comparatively smooth, except for hair, gland ducts and wrinkles. But the epidermis on the palmar and plantar surfaces bears friction ridges.

Arranged along the summit of each ridge is a single row of perspiration pores spaced about the width of a ridge apart (averaging about .48 millimetres). These pores are the ducts of "eccrine glands" one of the three major types of skin glands that occur in the body. The other two major glands are the "sebaceous glands" and the "apocrine glands". As the products of all of these glands can be found in latent deposits, a general knowledge of them will enhance the understanding of a latent deposit.

Sebaceous Glands

Sebaceous glands are present everywhere on the skin except on the palmar and plantar surfaces. They are most abundant on the scalp and face and invariably found in association with the many types of hair structures. The main product of the sebaceous gland is a fatty greasy wax called "SEBUM". It is composed of very complex organic chemical compounds which, in the main, can be categorised as members of the diverse chemical family known as "lipids". Sebum is formed by bacteria decomposing keratin within the gland and is fluid within the duct but solidifies as skin surface temperature. More fatty acids are also formed on the skin by bacteria reaction with produced matter. Eccrine are also formed on the skin by bacteria reaction with produced matter. Eccrine gland secretions emulsifies sebum facilitating its spread over the skin and forming a water repellent film called "Sebum cutaneum". This film unquestionably absorbs latent print deposits left on living skin. If the "sebum cutaneum" is cleaned from the skin, excretion by the glands increases at a rapid rate until the sebum layer reaches a certain thickness. The time interval necessary to restore the "sebum cutaneum" has been determined to be in the neighbourhood of three hours.

Sebum

Sebum is present in varying quantities in latent deposits and is the most durable matter of a latent deposit. It is thought that its occurrence in latent deposits is due to friction ridge contact with other parts of the body but lipids are formed by the keratinisation of the ridged skin also, but to a much lesser degree.

Apocrine Glands

Apocrine glands are located in the armpits, the anogenital region, the chest, the external ear canal, eyelids, and occasionally on the face, scalp and abdomen. The duct of the apocrine gland is usually sited in the duct of a sebaceous gland. Their secretions are cellular granules which are produced in the glands and which are dissolved at the apex of the duct. The main constituents are proteins, carbohydrates, cholesterol and iron. The apocrine gland primarily serves as a scent gland and only becomes functional at puberty.

They are more developed in women and best developed in Africans. Only minute quantities of their secretion can be identified in latent deposits.

Eccrine Glands

Eccrine glands are present almost everywhere in the human skin. They are found in greatest abundance in the palmar surfaces, plantar surfaces and armpits. They are the only skin glands on the palmar and plantar surfaces. Their occurrence averages at about 558 per square centimeter in the finger ridges of white males but can occur at a much higher rate in dark skinned people where they average about 950 per square centimeter. The occurrence rate is higher in the toes than in the fingers but is lower in palms and soles, averaging about 435 per square centimeter. The occurrence rate in the forehead is about 1/2 that of the palms and on the cheeks about 1/5. They primarily serve in the regulation of body heat and ridding the body of some of its waste products.

The glands are capable of producing prodigious quantities of fluid to serve as a coolant. The glands themselves simply excrete, hence the name "eccrine", and they are supplied from the blood plasma. The fluid in the gland is pumped to the epidermal surface by a muscular-like contraction of the cells of the gland itself.

Pure eccrine fluid in the gland is an alkaline aqueous solution of in-organic and organic (non-lipid) compounds. Research shows that it is made up of about 99.5% water and about .5% solid matter, about 1/2 of which is in-organic salts and the remainder organic substances. Some of these organic substances have yet to be identified.

But the latent deposit that can be developed has changed considerably from the gland fluid.

Some Composition Changes of Eccrine Gland Fluid
(N.B. Normal palmar and plantar gland secretions, not high rate secretions or contamination from other parts of the body or foreign sources, have been taken into consideration only when specifically stated.)

1. Changes in the Eccrine Duct

(a) Ductal cells undergo partial keratinisation at a low level but are fully keratinised at the granular layer level of the epidermis. Keratinisation continues to the mouth of the duct and on the ridged skin surface and is a continual action. This keratinisation is a source of skin surface lipids, the durable matter which is able to be developed.

(b) Glycogen, the chief carbohydrate of body tissue is abundant in the secretory lining of the glands, decreases or disappears on the skin. This is a continual action.

(c) Bacteria decomposition of urea, a body waste present in the gland, creates ammonia. This is a continual action.

2. Changes on the Skin

The fluid is in microscopic globule form, each globule varying in chemical composition and diameter (from .0056 to .048 micrometers). Lipids appear as a surface film over the gland excretions and spread with the gland excretions, eventually forming a complete surface film. The lipids are still fluid or semi-fluid.)

(a) The fluid has changed from alkaline to slightly acid.

(b) The water content has been reduced considerable through evaporation and chemical reaction with other fluid Compounds or consequential compounds (termed "hydrolysis"). This is a continual process.

(c) The lipid concentration has increased by continued keratinisation and by virtue of its more stable nature, accumulates as a surface film. (One researcher states the build up is 1/1000 millimetre per hour.) This is a continual process.

(d) Lipids themselves hydrolyse oxidise and decompose forming new compounds thus increasing the viscosity of the fluid. This is a continual process.

(e) The remaining water carries higher levels of in-organic salt concentration which increases continually with water evaporation his evaporation also increases the viscosity of the fluid.

(f) Lactic acid is formed from pyruvic acid and the reaction is readily reversible. Both acids react with other matter and high initial concentrations are present at the start of perspiration but subsequently decrease with perspiring duration.

3. Changes in the Latent Deposit

Research shows that a natural deposit is made up (physically) of a monolayer of semi-solid substance and the actual ridges are delineated in a more or less, continuous arrangement of minute droplets of fluid of various shapes and sizes.

Also, it must be kept in mind that latent deposits are animal waste. Under most conditions, chemical reactions, oxidation, bacterial attack and drying out will create changes and eventually, the deposits will be dissipated.

(a) Research shows that there is very little water present in the deposit, as the drying rate shows no dependence on environmental humidity.

(b) Crystals of in-organic compounds may be present soon after the deposit is made. This must be the result of water evaporation.

(c) Bacteria already present will continue to decompose the deposit.

(d) It is logical to assume that remaining lipids that are capable of oxidising and hydrolysing will do so.

(e) Urea is known to migrate from the deposits.

(f) The non-mixing of the chemical components causes variations in the drying rate.

(g) The initial thickness of the fluid of a single ridge deposit decreases. This may be caused by evaporation of the more volatile constituents, or the solidifying of compounds as the deposit temperature cools to that of the receiving surface. If the receiving surface temperature is higher than the skin surface temperature, the latent deposit can become more fluid and spread, losing identifiable ridge detail resulting in a finger shape blob.

(h) The aging of a latent is accompanied by an increase in its viscosity. It will eventually dry and harden and lose its adhesive properties.

Inorganic Matter Found in True Latent Print Deposits

BASIC ELEMENT	Compounds Found in True Latent Print Deposits
1. Bromine	Inorganic salts
2. Calcium	Inorganic salts
3. Carbon	Organic substances
4. Chlorine	Inorganic salts
5. Cobalt	Organic substances
6. Copper	Inorganic salts and organic substances
7. Fluorine	Inorganic salts
8. Hydrogen	Water and organic substances
9. Iodine	Inorganic salts
10. Iron	Inorganic salts and organic substances
11. Magnesium	Inorganic salts and organic substances
12. Manganese	Inorganic salts and organic substances
13. Molybdenum	Organic substances
14. Nitrogen	Organic substances
15. Oxygen	Water and organic substances
16. Phosphorus	Inorganic salts and organic substances
17. Potassium	Inorganic salts
18. Sodium	Inorganic salts
19. Sulfur	Organic substances
20. Zinc	Organic substances

Organic Matter Found in True Latent Print Deposits

A. Pyruvic acid

B. Lactic acid

C. Glycogen

D. Nitrogenous compounds
1. Ammonia
2. Urea
3. Uric acid
4. Creatine
5. Creatinine
6. Amino acids:
    a. Alanine
    b. Aspartic acid
    c. Arginine
    d. Cystine
    e. Glutamic acid
    f. Glycine
    g. Isoleucine
    h. Leucine
    i. Lysine
    j. Methlonine
    k. Serine
    l. Threonine
    m. Valine
    n. Phenylalanine
    o. Tyrosine
    p. Histidine
    q. Proline
    r. Amino-butyric acid
    s. Citrulline
    t. Ornithine
    u. Taurine

E.
1. Phospholipids
2. Sterols:
    a. Cholesterol
    b. Cholesterol esters
    c. 7-dephydrocholesterol
    d. Lathosterol
3. Fatty acids

F. Water soluble vitamins:
1. B-complex vitamins:
    a. Thiamin
    b. d-riboflavin
    c. Folic acid
    d. Choline
    e. Pyrodoxin
    f. Niacin
    g. p-aminobenzoic acid
    h. Inositol
    i. Pantothenic acid
2. Ascorbic acid (Vitamin C)

Other matter, yet to be identified, is known to be present. Nicotine, morphine, alcohol and fluoride may also be found in some deposits.

Lipids

Due to their complexity and number, it is not possible to attempt a comprehensive listing of all the skin surface components and researchers are identifying more as time progresses. It can be seen in the aforementioned charts that most of the organic components are acids but due to their viscosity, are commonly referred to as oils, even though chemically they are not oils. Also, consistent with oils, they have low melting points and are usually liquid at room temperature (about 80`F). Most of the components can be classed as "Lipids". The components of sebum, the product of the sebaceous gland can also be classified as lipids, but are predominantly fatty and waxy by nature, although chemically, they are mainly acids. Generally, they have high melting points and are solid at room temperature.

There are some lipids of a waxy consistency present in true palmar and plantar surface matter deposits but the concentration is increased by contamination from other parts of the body and other sources.

Set out below are the main lipid components of sebum.

Free fatty acids
30%
Triglycerides
27%
Diglycerides
4%
Monoglycerides
2%
Wax Esters
22%
Squalene
10%
Cholesterol
2%
Cholesterol Esters
2%
Hydrocarbons
1%

Research in this area is continuing and there is an increasing awareness of the number of compounds and their complexity. In 1950, about 50 lipid compounds had been identified. In 1970, the number had increased to over 300.

The presence of lipids in pure latent deposits is dependent on the keratinising of the eccrine duct and the epidermal surfaces and the consequential chemical changes that take place. The skin surface film of the lipids is mainly an oily like fluid whose viscosity increases with time due to chemical change and evaporation of its more volatile components. One researcher found that the levels on the fingers of some of the oily compounds doubled and a wax like compound quadrupled in the space of about four hours.

The amount of this surface film varies not only from previously mentioned influencing factors, but also as a result of cleaning the skin surface or its removal by contact with porous, absorbent, or abrasive surfaces. Experience has shown that ridged skin which has just been cleaned, or has had contact with other surfaces to the extent that all or most of the surface film has been removed, may not leave a latent deposit that is detectable by present day methods.

When high rate secretions by the glands occur, the water content of the skin surface matter increases noticeably. The lipid content under these conditions is dependent mainly on the amount present on the skin before the increased gland secretions commenced. The rates of keratinisation, chemical changes, and evaporation are slow compared to the high secretion rates that the glands are capable of. The lipid matter present forms a surface film and is laid down first on contact with an object. The lapse of time will allow chemical reaction and evaporation to normalise conditions on the skin and in latent deposits.

Lipids are readily soluble in benzene, ether and similar fluids, but generally are impervious to water. But the water repellent skin surface film does contain some compounds which are water soluble and allow the breakdown of the film. Warm water and cleaning compounds accelerate this breakdown.

Latent Deposit Explained in Lay Terms

In summation, any moist or sticky substance which can be transferred by friction can form a latent print. The list of foreign matter that can contaminate friction ridge skin is endless and it would be pure conjecture, in most instances, to say that a latent print deposit is composed of this or that.

Uncontaminated friction ridge skin matter is in a constant state of change on the skin and when deposited and knowledge of the processes and compounds involved is not complete. **But if asked to explain the composition of a true latent print in lay terms, it would suffice to say that it is the residue of friction skin oils and waxes deposited on a surface upon contact with friction skin.**

If the latent print has been developed chemically, it would be equally accurate to say that the latent print contained the component matter that the chemical developer reacted with, eg.

NINHYDRIN LATENT
Amino acids or ammonia

IODINE LATENT
Triglycerides (fats)

SILVER NITRATE
Sodium or potassium chlorides (salts)

Chemical Aspects Involved in Common Latent Development Methods.

Powders

The traditional method of applying specially prepared powders to smooth, clean, non-porous surfaces to develop latent deposits incurs no known chemical reaction. The powders simply adhere to the minute droplets of sticky residue impressed on the surface by the ridged skin.

A strong, durable, and very pronounced developed impression may be a more reliable indication of the abundance of skin surface matter, the presence of sebum or other foreign matter deposited, rather than its freshness.

Conversely, a thin, ill-defined impression may be caused by the lack of skin surface matter deposited, rather than the changes and drying out caused by the lapse of time.

Hands that have just been cleaned are, generally, not likely to leave sufficient skin surface matter that can be developed by present day powders.

The contact pressure of ridged skin with ample surface matter can vary the amount of matter deposited. Contact pressure of 250 grams will produce a very fine ridged latent deposit with little powder adhesion capability, whereas, contact pressure of 2kgs to 7kgs will generally produce strong well defined deposits with good powder adhesion.

Ninhydrin

This chemical reacts with amino acids to produce a pink-purple stain. Ammonia also reacts with ninhydrin and will cause the often encountered red-brown coloured impressions developed by this method. This latent development method is used on the porous and absorbent surfaces of most papers and unsealed wood.

Amino acids have an affinity to the cellulose of paper and wood. The amino acids present in latent print matter will migrate from the latent print deposit into the cellulose structure of the paper or wood and can remain bonded in the structure for considerable periods. Ninhydrin can also react with certain types of paper.

The formation of the amino acids and ammonia on the skin surface is known to decrease with high rates of perspiration. Amino acids formation decreased with increasing age of the individual.

Tests also reveal that long duration contact between the ridged skin and the receiving surface produces stronger developed impressions.

This may be an influencing factor as to why a document can be handled by many people without leaving detectable impressions. Possibly, another contributing factor to this situation is that constant contact with paper probably reduces or removes the skin surface film of the ridged skin.

The often encountered ninhydrin developed latent with ridges that appear to be made up of dots consistent with the position of gland ducts, may be an indication that a dot may be the only location where amino acids or ammonia are present, or where the amino acids or ammonia are fluid enough to migrate, or where the amino acids or ammonia have not changed chemically.

Iodine Fuming

Iodine is absorbed and bonded chemically to certain compounds found in true latent matter and sebum. It causes the deposit to become yellow-brown in colour. The amount of iodine absorbed is dependent on the amount of suitable compounds present in the latent deposit. Generally, these compounds, "Triglycerides", form part of the oily matter.

The chemical bond is not a permanent one and is readily reversible, which in turn can cause the rapid loss of the yellow-brown colour.

Silver Nitrate

Silver nitrate reacts chemically with the chlorides (sodium and potassium chlorides being the most prevalent) of skin surface matter to produce silver chloride. When exposed to light, the silver chloride decomposes and deposits black coloured silver in the ridges of latent print deposits.

Etched Prints

Latent print deposits are acidic and react with some metals resulting in the ridge formation being eroded into the metal. Generally, the actual latent deposit is eventually and fairly rapidly completely destroyed in this reaction and will not be able to be developed. These prints are visible and permanent and their age generally cannot be determined. However, sometimes all the latent matter may not be spent and if development is attempted soon after the deposit is made, a thin adhesion may occur. The reactions appear to commence at the edges of a ridge and progress towards the middle of the ridge which is where any powder adhesion may occur.

Physical Properties of Friction Skin Matter Deposits

Normal chance latent deposits take the form of microscopic droplets and continuous ridge films. Latent deposits formed by induced perspiration are made up of independent droplets, whereas deposits of sebum rich matter are delineated by continuous pools or large irregular shaped islands of matter.

Natural chance latents display both configurations of matter, on most surfaces. On some plastic surfaces, described as "low energy" surfaces, the deposit takes the form of droplets only, and usually smaller quantities of matter are left no matter how much matter is available on the ridged skin.

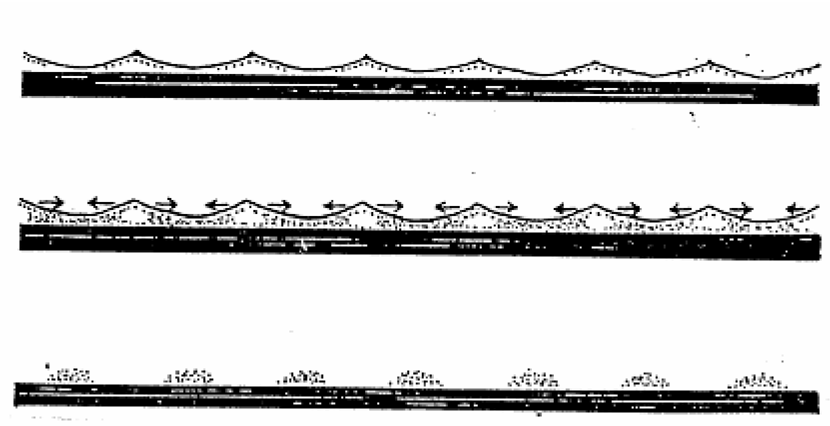
Research has proved that ridged skin surface film contact with the receiving surface is much larger than that covered by the droplets of the deposits.

The surface of each individual friction ridge is microscopically rough and actual ridge contact with a surface is only a small proportion of the total ridge area. The skin surface matter present forms an enveloping film over the whole friction ridge area, filling in the microscopic gaps. It is the skin surface film that forms the main contact with a surface and also increases the apparent contact area.

On contact, the skin surface matter is sandwiched between the ridged skin and receiving surface. Lifting the finger caused the skin surface film to rupture and form droplets which immediately recede from each ridge contact edge to form the individual ridge impression.

It is known that by increasing the pressure from a light touch to an extremely heave contact in making an impression, the area of ridge contact increases from 55% to 80% of the total ridge area and the width of ridge contact with the receiving surface doubles from about 125 micrometers to about 250 micrometers. Also, pressures in excess of 7kgs usually causes obliteration of parts of an impression by the deformation or movement of the actual skin ridges.

Possibly, heavy pressure and/or ridge deformation and/or movement of ridges causing large actual ridge contact and squeezing skin surface matter into the ridge valleys, may result in the ridge surface film joining one ridge to the next on the receiving surface. This in turn, could cause the droplets at the edge of the individual ridge to flow to the droplets at the edge of the adjoining ridge creating an impression of the friction skin valleys (the sulci) rather than the ridge summits. These circumstances may also be a cause of variations in ridge characteristics found in latent impressions.

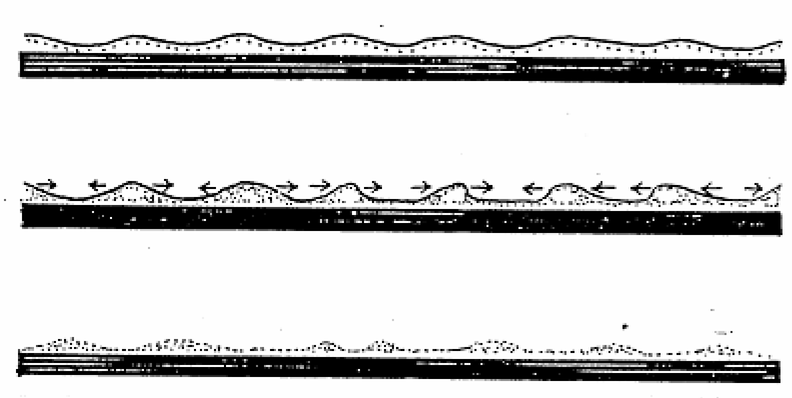


An Exaggerated Illustration of Normal Ridge Contact

(a) The skin surface matter sandwiched between the friction ridges and the receiving surface on contact.

(b) The sandwiched skin surface matter at the breaking of contact showing the anticipated movement towards the middle of actual ridge contact.

(c) Resulting normal latent deposits. A true impression of the friction ridges.



Exaggerated Illustration of Heavy and/or Deformed Ridge Contact

(a) The skin surface matter sandwiched between the friction ridges and the receiving surface and squeezed into the sulci covering the entire receiving surface.

(b) The sandwiched skin surface matter at the breaking of contact showing movement towards the concentration of skin surface matter in the sulci.

(c) Resulting latent deposits. An impression of the sulci.

This action may also be responsible for variations in characteristics.

Observations of Latent Deposits

Observations of the deposits have revealed that: -

(1) There are large initial changes in the thickness due to the evaporation of the more volatile constituents of the droplets.

(2) As aging proceeds, the surface shape of a single ridge deposit becomes irregular and its height reduces from 600-800 micrometers to 100-200 micrometers.

(3) There is a change of shape of the top surface of a single ridge from convex to concave which indicates the presence of solid matter or at least material that becomes solid as the deposit temperature reaches that of the receiving surface.

(4) Aging increases the viscosity of the deposit.

(5) There is strong evidence that the monolayer between droplets is lipid material.

(6) The non-mixing of the various chemical compounds of the droplets causes variations in the drying rates from one droplet to another.

(7) The droplets have low water content as there is no systematic dependence of the drying rate upon relative humidity.

(8) The amount of matter deposited is dependent upon:-

(a) The amount and nature of skin surface matter available;

(b) The pressure of the contact and/or the duration of the contact;

(c) The receptive capabilities of the receiving surface.

The thickness of the deposit varies widely within itself and varies from deposit to deposit.

Chemical Composition of Sweat in Man (mg/100ml of sweat unless otherwise indicated.)

1.	Water %	(99.2 - 99.7)
2.	Calcium	2.1
3.	Chloride	30 - 300
4.	Iodine (ug)	0.8
5.	Iron	27
6.	Magnesium	0.2
7.	Manganese (ug)	6
8.	Nitrogen ammonia	2.5 - 3.5
9.	Nitrogen total	31
10.	Phosphorus	0.5
11.	Potassium	21 - 126
12.	Sodium	29 - 294
13.	Sulphur total	0.7 - 2.5
14.	Non-protein nitrogen	27 - 64
15.	Amino acid N	1.6 - 4.8
16.	Creatinine	0.1 - 1.3
17.	Urea	12 - 57
18.	Uric acid	0.7 - 2.5
19.	Argenine	5.8 - 21.4
20.	Histidine	6 - 10
21.	Isoleucine	1.0 - 3.6
22.	Leucine	1.2 - 4.2
23.	Lysine	1.4 - 3.2
24.	Phenylalanine	1.0 - 3.5
25.	Threonine	1.7 - 9.1
26.	Tryptophan	0.4 - 1.8
27.	Tryosine	1.2 - 5.0
28.	Valine	1.5 - 4.5
29.	Red. Substances as glucose	2.8 - 4.0
30.	Volatile acids (ml. o.1N)	2.4 - 5.6
31.	Lactic acid	45 - 452
32.	Ascorbic acid (ug)	0 - 200
33.	Biotin (ug)	trace
34.	Chlorine (ug)	0.3 - 1.5
35.	Folic acid gp. (ug)	0.53 - 0.88
36.	Inositol	15 - 36
37.	Nicotinic acid (ug)	7 - 22
38.	Pantothenic acid (ug)	2.2 - 4.4
39.	P-Aminobenzoic acid (ug)	0.08 - 1.7
40.	Pyridoxine (ug)	0.08 - 0.18
41.	Pyridoxal (ug)	0.4 - 8.25
42.	Riboflaven (ug)	0 - 0.5
43.	Thiamine (ug)	0 - 0.6
44.	Spec. Gravity	(1.001 - 1.006)
45.	pH	3.8 - 6.5
46.	Max. prod. rate ml/min.	17.7 - 38.2