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fA study of Biological trace evidence in forensic science

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Abstract:

The foundation of all forensic science as we know it today, Locard's concept of exchange, is the key to the existence of trace evidence. It is difficult for a criminal to act, particularly given the severity of a crime, without leaving signs of this presence, according to Sir Edmond Locard. In other words, Locard held the view that there is always a transfer of material across the contact boundaries whenever two things come into touch with one another. Paul Kirk further clarified that no criminal can commit a crime without either leaving behind or removing evidence. The person may leave behind or take up tiny waste such as pollens, plant material, dirt, or dust upon interaction with the environment or another person. As a result, it is almost difficult to interact with the environment without leaving some kind of trace.

Keyword: Trace, Evidence, Chemical, Analysis, forensics

Introduction:

In a criminal investigation, numerous types of evidence are presented to the investigating agency and courts. A case investigator's ability to identify, gather, and utilise evidence will determine whether or not the investigation is successful. Numerous types of evidence may be found at the crime scene. It might be documentary evidence or physical proof. Physical evidence includes any substance or item, no matter how little or large, that is found at the crime scene. Therefore, there is an endless variety of tangible evidence that may be found at a murder scene. It may be as big as a structure or as little as a hair strand, DNA, or particle of dust, for example. Trace evidence is tangible proof that is tiny or minuscule in size. In order to aid in the investigation of these instances, any little bits of material that are gathered from crime scenes are referred to as "trace evidence." Since trace evidence has the ability to reveal what truly occurred and who was involved, it is often referred to as the "Silent Witness." Hair, fibre, bloodstains, paint, glass fragments, dust, skin, feathers, insects, bodily fluids, gunshot residue, etc. are typical examples of trace evidence. Due to their minuscule size and ease of movement

between things and people, this evidence is very important in criminal investigations. It may be used to look into any criminal activity, including theft and terrorist attacks. If this trace evidence is correctly identified, retrieved, kept, and submitted for analysis, it may provide important information about the occurrence and make it possible to connect the crime scene, suspect, and victim.

Significance of Trace Evidence:

Even though trace evidence is tiny in size, it plays a significant role in crime scene investigation for the following reasons:

- Because trace evidence is small in size, it often goes unobserved by the perpetrator and other witnesses.
- They are traded practically in all sorts of crimes, thus there is a greater likelihood that this evidence will stay undamaged and undisturbed at the crime scene.
- Trace evidence may be accurately recognised and linked with its potential source, much as other types of hint material.
- It aids in reconstructing an event's chronology, identifying the crime's modus operandi, and pinpointing its location.

It could provide details about the suspects and perhaps connect one of them to the tragedy.

How traces are created as evidence: When a little fragment of material shatters or separates from one surface and moves to another surface by physical touch, trace evidence is created.

- The properties of the surfaces as well as the material's capacity to shed rely on how much material travels from one surface to another.
- The duration, surface area, and force delivered during the physical contact.
- The materials being transferred's dimensions and characteristics.
- The victims' and offenders' post-transfer actions throughout the course of time.
- The post-transfer condition of the materials.

Types of Trace Evidence:

All types of chemical, physical, and biological entities, regardless of their modest size or quantity, may leave traces. They may be made of organic or inorganic components, plant materials, animals, or even lower forms of life. Although there are a virtually limitless number

of elements that may be utilised as trace evidence at a crime scene, hairs, fibres, plant materials, paint, glass, GSR, blood stains, and soil are the most typical kinds that are examined in the lab. The type and make-up of the evidence, however, may differ from case to case.

Since they come from the body and are connected to the victim, witness, or suspect, hairs are valuable as trace evidence. Comparing the disputed hair samples recovered at the murder site with known samples obtained later from animals or people suspected of having left the hair might provide crucial information. If hair roots are present, it also aids in the individualization of a person. Since the origin of fibres can be determined, they may be used in the investigative process much like other types of trace evidence. The thread-like components of fabric or textile materials are called fibres. Fibre evidence is a kind of circumstantial evidence that supports any other circumstantial or strong evidence against a criminal.

It may be possible to find trace evidence in a broad range of plant materials. Wood, bark, flowers, petals, leaves, seeds, plant hair, fibres, sawdust, and other plant elements may all be used to pinpoint a place and a period. It also reveals the dates and locations of a person's departures. Due to their small weight, these materials are quickly transferred to involved clothes, shoes, weapons, and vehicles. Like plant material, dirt is often connected to most crimes involving outside activities, although it may also sometimes be discovered at the scene of an inside crime. The offender, the victim, the crime scene, the car, the offender's weapon, and other personal belongings may all be connected by the soil. Sometimes the dirt from a particular region may also be found in shoe prints, footprints, and tyre impressions. This can be useful in locating a certain place.

Glass may be used to collect other types of trace evidence, such as fingerprints or blood from a shattered window, but glass itself is considered a kind of trace evidence. Glass shards may be extremely minute and may be discovered on the side of the road in a hit-and-run case, which may provide a clue confirming the identify of a suspected car. Alternatively, glass shards may be discovered on the clothing of an accused attacker when a bottle is used as a weapon. They benefit from being more durable and resistant to deterioration than biological evidence over a longer period of time. Glass pieces are typically found after burglaries and crimes involving accidents.

Fine debris known as GSR is ejected from the gun when a round of ammo is fired. In a forensic inquiry, GSR analysis showed a variety of problems, ranging from identifying the shooter to connecting a bullet with a wound. Additionally, it aids in the reconstruction of crimes involving

firearms. In most hit-and-run incidents, paint evidence is discovered. Other sorts of crimes, such as burglaries and murder cases, may also include the use of paint as a piece of evidence. When a car collides with a painted surface, paint chips and smears are often left behind, and during burglaries, the instruments used to break in may also leave paint streaks. As a result, examination of a paint sample may help in both burglary and accident investigations by identifying the suspect car.

Collection of Trace Evidence:

There are several techniques for finding trace evidence. General visual searches, visual searches combined with various light sources, such as oblique illumination and alternative light sources (UV, laser, high intensity), and visual searches combined with a magnifying glass are some of these techniques. Most recovery and collecting techniques for trace evidence are straightforward and minimally invasive. The methods utilised to gather trace evidence are as follows:

Picking: Clean forceps may be used to collect trace evidence like fibre or hair.

Lifting: In this technique, tiny traces like dust, pollen, and other particles are collected using an adhesive-bearing substrate like tape.

Scraping: This technique is used to gather traces like paint chips, bloodstains, etc. In order to remove residues from an item and transfer them to a collecting surface, a flat instrument, such as a clean spatula, is utilised.

Vacuum Sweeping: A vacuum cleaner and a filter trap may sometimes be used to extract trace evidence from a thing or an area.

Clipping: Clipping may be used to retrieve any traces of evidence found in a fingernail. One cuts one's fingernails using clean clippers or scissors.

Combing: Clean combs or brushes may sometimes be used to retrieve traces of evidence from a person's hair.

Analysis of trace Evidence:

Due of the trace's tiny size and sheer volume, analysis is a difficult process. The examination of this kind of evidence differs from case to case and is based on the nature and makeup of the evidence. A forensic analyst will investigate, discover, and categorise trace evidence using a variety of analytical procedures. The analyst will then determine the materials' primary

components and compare them to samples of other evidence to determine their common source. Trace evidence investigations combine microscopic and instrumental analysis to properly assess a particular sample's characteristics and ascertain its relevance to the crime.

Microscopy: Based on certain morphological characteristics, numerous microscopic particles may be most effectively detected. Microscopy is the most popular and significant tool to evaluate trace evidence. Despite having almost identical chemical compositions, wood fibres, non-woody botanical fibres, lyocell fibres, rayon, etc., may all be distinguished from one another and from one another within a group based on their microscopic features. Based on their optical characteristics, amorphous or crystalline transparent particles, man-made fibres, glass minerals, different chemical crystals, and pharmaceuticals may be recognised when they seem as a single microscopic particle. For the examination of various traces, many kinds of microscopes are utilised. For instance, polarised light microscopy may be used to identify man-made fibres, and a scanning electron microscope can be used to analyse the morphology and chemical makeup of gunshot residue.

Chemical analysis is a practical method that may be used to determine if metallic particles are inorganic or organic. The majority of the time, a separate chemical test is used to analyse the gunshot residue.

X-ray spectroscopy: This technique may be very helpful for determining the elements of traces, particularly those found in paint, building materials, dust, and dirt. With the use of this technology, the elemental makeup of a minute particle may be determined in less than a second. Both the inorganic and organic particles may be analysed equally well using this procedure.

IR-Micro spectroscopy: This technique is excellent for figuring out the molecular make-up of tiny, inorganic particles. These methods may be used to analyse traces such as those left by plastic, paint, synthetic fibres, and other substances. This method uses a reflecting microscope and a Fourier Transformed Infrared Spectrophotometer.

Conclusion:

If a portion of anything, no matter how minute, can be recovered during the inquiry, then it is considered to be a piece of trace evidence. Trace evidence includes everything that can be

handled, damaged, moved, shed, and left behind during the commission of a crime. Any form of criminal investigation may benefit from the use of trace evidence. Due to the fact that it establishes a crucial connection between the suspect, the crime scene, and the victim, trace evidence is an essential component of the investigation. The state of the evidence, as well as what may be learned from its examination and how it is employed in the investigation, all have a role in determining the value of trace evidence.

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