The Interpretation of Paint Evidence through the Use of Population Studies: Two Case Examples

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Introduction

> Approach for the interpretation of mass produced items, like paint, based on **objective** data;

> Current situation in trace evidence: the evidence and its putative source are undistinguishable after analysis.

  **What is the evidential value?**

> Information about the **rarity** (or commonness) of the occurrence of the observed features is needed;

> Two population studies were carried out and applied to two casework examples.
Case 1

A burglary case

Paint traces recovered on a crowbar
Paint was the only evidence recovered in this case.

Case 1
Case 1

> Three different groups of traces were observed:
   Blue, Pink and white traces

> At the scene, reference paint was collected from the forced door:
   Pink & Blue two-layer system

> Mission: do such traces come from the putative source?

> Comparative analyses were performed using:
   Optical methods
   FTIR spectroscopy
   Raman spectroscopy
Case 1

FTIR spectroscopy

Blue trace recovered on the crowbar

Blue reference paint coming from the forced door
Case 1

Raman spectroscopy

Blue paint trace recovered on the crowbar

Blue reference paint coming from the forced door
Conclusion

After the analyses, the blue and pink traces are undistinguishable from the blue and pink two-layer reference paint coming from the forced door.

What is the evidential value?
Case 2

*Hit-and-run accident between two vehicles*
Case 2

- Red non-metallic traces recovered on a grey metallic *Honda Legend*;

- Reference paint from a red non-metallic *Ford Fiesta*.

- Mission: do the red traces come from the putative source?

- Comparative analyses were performed using:
  - Optical methods
  - FTIR spectroscopy
  - Raman spectroscopy
Case 2
Case 2

FTIR spectroscopy

Substrate clearcoat
Reference paint
Red trace
Pigment Red PR254: dyketo pyrrolo pyrrol

Raman spectroscopy

\[ \lambda_{\text{exc}} = 785 \text{ nm} \]

Case 2

Red trace

Reference red paint

Raman shift (cm\(^{-1}\))

Pigment Red PR254: dyketo pyrrolo pyrrol
Conclusion

After the analyses, the red trace recovered on the damaged vehicle is undistinguishable from the red non-metallic reference paint coming from the suspect’s vehicle.

What is the evidential value?
What is the occurrence of the observed profiles in a relevant population?

**Approach:**
Obtain objective data for the interpretation of the evidence

*For paint (as a mass produced item):*
Utilization of the rarity of physical and chemical features like: color, binder type, pigments and extenders.
Population studies

Observation of the variations of the different features (polymorphism) of a set of reference samples, being:

a) randomly selected, and

b) representative of a population of interest.
Case 1

A burglary case

Paint traces recovered on a crowbar
> 131 household paint samples were collected from forced entries at burglary scenes by police officers.

> Criterion: random.

> entries: doors (front and back), windows, glass-doors.

> Painted surfaces: wooden and metallic
Population studies - Case 1

Color distribution (N=131)

- White: 21
- Brown: 12
- Grey: 9
- Red: 7
- Blue: 7
- Green: 7
- Yellow: 3
- Black: 2
- Violet: 2
- Colourless: 1

Population studies - Case 1
Population studies - Case 1

FTIR spectra of the 7 blue reference household paint samples

FTIR spectrum of the blue trace

FR05 - ALK OPH+Talc+TiO$_2$
FR06 - ALK OPH+Talc+TiO$_2$+CaCO$_3$
NE02 - ALK OPH+Talc+TiO$_2$+CaCO$_3$
FR15 - ALK OPH+Talc
NE28 - ALK OPH+TiO$_2$
VD26 - ALK OPH+CaCO$_3$
VD38 - ALK TER+TiO$_2$+BaSO$_4$
Population studies - Case 1

Raman spectra of the 7 blue reference household paint samples

- Trace
  - Pigment Blue 15
  - Fluorescence
    - Pigment Violet 23

\[ \lambda_{\text{exc}} = 514 \text{ nm} \]
Case 2

Hit-and-run accident between two vehicles
Foreign paint traces were taken from 154 collided cars.

These samples were collected in car body shops.

When a damaged car went to a car body shop for repair, the part of its body carrying traces was cut out and transported to our laboratory.

Criterion: random.
Color distribution of traces recovered on damaged vehicles (N=154)
Population studies - Case 2

Non-metallic red traces: 7%
Of the red-non metallic samples (7%), NO undistinguishable FTIR spectra were observed.
Conclusion

- Objective approach for the interpretation of a very common mass produced item;

- Collection of data on the rarity of physical and chemical features of a reference population;

- Information about polymorphism;

- Suitable spectroscopic methods.
The consideration of the paint properties such as color, IR and Raman profiles demonstrated the high rarity of the frequency of distribution of the observed features;

For both cases our opinion was that: *The rarity of such profiles strongly supports a common origin.*
Questions or comments?

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