# EXPLORING THE FORENSIC POTENTIAL OF NOVEL SOIL PROFILING METHODS

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## INTRODUCTION

- The organic component of soil contains a wide variety of biochemical signatures
- The diversity in these signatures offers potential for developing novel investigative tools for forensic application

- We examined the discriminatory power of:
  1) plant wax profiles
  2) soil microbial DNA profiles

## 1. PLANT WAX PROFILES:

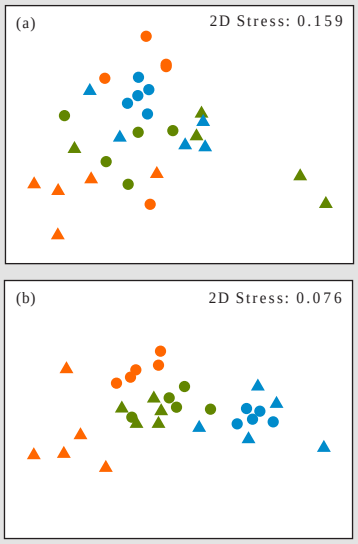
- include long-chain *n*-alkane ($C_{21}$-$C_{35}$) and fatty-alcohol ($C_{20}$-$C_{34}$) compounds
- are largely dependent on vegetation inputs
- could potentially provide investigative intelligence as to the likely vegetation coverage of an unknown soil sample

*HYPOTHESIS: plant wax profiles depend more on land-use vegetation (LUV) than on location*

### METHODS

- Soil was collected from 3 urban LUV x 2 cities: Shrub Border, Grassland, Woodland x Aberdeen, Milton Keynes
- Samples were ground and extracted for alkanes and alcohols as described in Dawson et. al. 2004, and analysed by GC and GC-MS respectively
- Data analysis: Relative abundance data were root transformed before forming a Bray Curtis resemblance matrix. The resemblance matrix was used in multi-dimensional scaling (MDS) (Primer 6)

### RESULTS




- Soil fatty-alcohol profiles (b) demonstrated greater potential in discriminating between LUV compared to *n*-alkane profiles (a)
- Soil fatty-alcohol profiles (b) from woodland soils were influenced by originating city, while other LUV classes were not
- *Soil fatty alcohol profiles proved to be more dependent on LUV than location*

Figure 1: MDS ordination plots of *n*-alkane (a) and *n*-alcohol (b) profiles from soil.
■ Shrub border, ■ Grassland, ■ Woodland: ▲ Aberdeen, ● Milton Keynes
Relationships between samples are indicated by relative distance. 2D stress indicates the level of confidence in the 2D ordination: <0.1 = unlikely to misinterpret the relationships.

## 2. SOIL MICROBIAL DNA PROFILES:

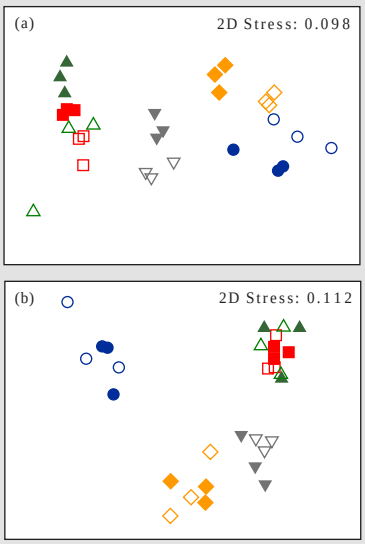
- include bacterial and fungal target micro-organisms
- may be influenced by post-transfer conditions, such as desiccation
- could potentially provide evaluative evidence in provenance-specific comparison of profiles

*HYPOTHESES: Soil bacterial and fungal DNA profiles discriminate soils from different geographical locations, but fungal profiles are more robust with air-drying*

### METHODS

- Soil was collected from 4 different locations in Scotland: Hartwood (sites 1 and 2), Glensaugh, Sourhope, Mharcaidh
- Soil treatments: non-dried and air-dried
- DNA was extracted using MoBio PowerSoil extraction kit
- multiplex-TRFLP method was used to obtain bacterial (1087r / 63fVIC) and fungal (ITS4r / ITS1fFAM) DNA profiles
- Data analysis: Relative abundance data were 4$^{th}$ root transformed before forming a Bray Curtis resemblance matrix. The resemblance matrix was used in MDS (Primer 6)

### RESULTS




- Soil bacterial (a) and fungal (b) profiles demonstrated clear ability to discriminate soils originating from different locations
- Soil fungal profiles (b) were unaffected by air-drying treatment, while bacterial profiles (a) were sensitive to air-drying
- *Soil DNA profiles proved to discriminate location*
- *Fungal profiles were more robust with air drying*

Figure 2: MDS ordination plots of bacterial (a) and fungal (b) DNA profiles from soil.
▲ Hartwood1, ■ Hartwood2, ▼ Glensaugh, ◆ Sourhope, ● Mharcaidh: ● non-dried, ○ air-dried
Relationships between samples are indicated by relative distance. 2D stress indicates the level of confidence in the 2D ordination: <0.1 = unlikely to misinterpret the relationships.

## IMPLICATIONS

- Plant wax profiles and soil microbial DNA profiles offer potential to develop novel profiling methods for forensic application
- Long-chain fatty alcohols may prove useful in providing *investigative* intelligence through eliminating / indicating likely land-use vegetation classes of an unknown sample
- Soil DNA profiles may prove powerful in *evaluative* comparison of evidence samples, allowing provenance- dependent comparison of soil evidence samples

- Further work required: to assess the sensitivity of novel profiling techniques to post-transfer factors, such as desiccation, persistence and contamination

http://www.macaulay.ac.uk/soilfit/

Acknowledgements: this work is funded by EPSRC and would not be possible without collaboration with several forensic practitioners and policing experts including Advance Forensic Sciences, Forensic Science Services, National Centre for Policing Excellence, the Universities of Exeter and Gloucestershire. Kind thanks are extended to R Darke of Milton Keynes Park Trust and H J Cooke of NSRI for access to and sampling of soils. The Council Parks Department of Aberdeen City and Shire are thanked for access and Nadine Thomas for molecular work.

Reference: Dawson et al. 2004. Principles, Techniques and Applications. (eds. Pye, K. and Croft, D.J.) Geological Society, London, Special Publications, 232, 269-276.