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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:

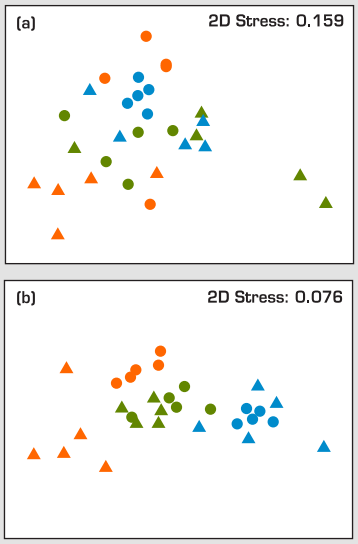
- include long-chain *n*-alkane (C_{21}-C_{35}) and fatty-alcohol (C_{20}-C_{34}) compounds
- are largely dependent on vegetation inputs
- could potentially provide investigative intelligence as to the likely vegetation coverage of an unknown soil sample

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:

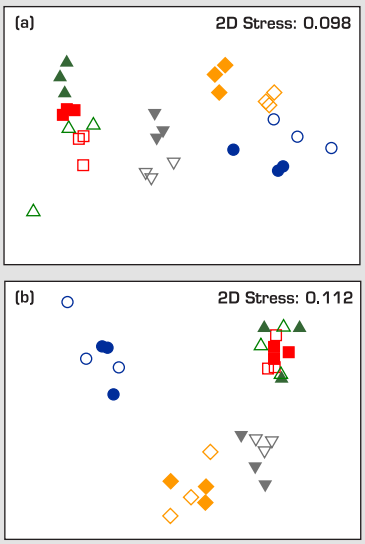
- include bacterial and fungal target micro-organisms
- may be influenced by post-transfer conditions, such as desiccation
- could potentially provide evaluative evidence in provenance-specific comparison of profiles

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/63fMC) and fungal (ITS4r/ITS1fFAM) DNA profiles
- Data analysis: Relative abundance data were 4th 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

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

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