EXPLORING THE FORENSIC POTENTIAL OF NOVEL SOIL PROFILING METHODS

LM Macdonald1, LA Dawson1, RW Mayes1, CD Campbell1, BS Singh1, J Ross1, MJ Brewer2, W Towers1, P Bellamy3, K Ritz2, C Jordan2: 1www.macaulay.ac.uk, 2www.bioss.ac.uk, 3www.cranfield.ac.uk, 4www.afbini.gov.uk
Email: l.macdonald@macaulay.ac.uk

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-alkanes (C_{27}-C_{36}) and fatty-alcohol (C_{26}-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 B)

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-alkanol (b) profiles from soil. Shrub border, Grassland, Woodland x Aberdeen, Milton Keynes

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: Hardwood (sites 1 and 2), Glenshaugh, Sorthope, Mharcaidh
• Soil treatments: non-dried and air-dried
• DNA was extracted using MoBio PowerSoil extraction kit
• multiplex-TRFLP method was used to obtain bacterial (16S rRNA) and fungal (ITS4F/ITS1FAM) 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 B)

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, 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. Hardwood, Glenshaugh, Sorthope, Mharcaidh: non-dried, air-dried

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

Acknowledgements: This work is funded by EPSRC and would not be possible without collaboration with several forensic practitioners and policing experts in the United Kingdom (UK). Support is also acknowledged from Acknowledgments: The University of Aberdeen and Scottish Forensics, who provided us with access to and sampling of soils. The Cranfield Department of Physical Sciences for access to and sampling of soils. The Scottish Office Environment Department for access to and sampling of soils. The Cranfield Department of Physical Sciences for access to and sampling of soils. The Scottish Office Environment Department for access to and sampling of soils.