“Murder mayhem and machines”

Giorgio Blom
Alison Davidson
Jamie Pringle
John Cassella
Warning
explicit scenes of death!
The Garden of Death

Police dig up three missing girls’ bodies

Hiker Finds Body of El Toro Woman in Shallow Grave

Murder riddle of the lady in the lake

A killer thought secret was safe

Check on missing women

Perils of being a Yo-Yo dieter:

Evil Brady boasts:

I’m Like Jack the Ripper

France for £1

60 Murders

STARTS TODAY
Timeline | Developments in forensic genetics

1900: First antibody test for blood group (ABO) introduced and used by Lallemand.
1920: Discovery and use of other blood groups and serum proteins (e.g., MNs, system, Rhesus, Lewis, Kell, haptoglobin) introduced.
1920s–1950s: Discovery and use of electrophoretic variants of red blood cell enzymes (e.g., phosphoglucomutase, glycylase) introduced.
1960s–1980s: Multilocus DNA fingerprinting developed by Jeffreys, followed by single-locus profiling (SLP).
1986: First commercial forensic PCR kit detecting SNPs at the polymorphic HLA-DQA1 locus by dot blot and oligonucleotide hybridization.
1987: First Y-STR described, and used in casework – acquittal of rape (Germany).
1992: First Y-STR described, and used in casework – acquittal of rape (Germany).
1995: First mass disaster case (Waco, Texas).
1997: DNA profiling from touched objects demonstrated.

See also REE 6 for further general background. HLA, human leukocyte antigen; mtDNA, mitochondrial DNA; STR, short tandem repeat.
• Last year in the United Kingdom approximately 200,000 people went missing of which 5,500 of those cases had a fatal outcome, which can range from suicide to accidents and misadventure to violent crimes.

• How you find those persons who have been murdered and placed in shallow, hidden, clandestine graves is the main topic of this presentation

• The use of laboratory scientific techniques and how they move into the ‘real-world’ will demonstrate the power and impact of science on our society
The use of chemical analysis, in addition to other search methods ranging from Victim Recovery Dogs to ground penetrating radar, in order to locate human remains has found its way into the American juridical system, although the research and methodology were not ready at the time. This indicates that chemistry has a potential to aid in the detection of human remains, although this area of research still needs further exploration.
Where to start?
Grounds for prosecution

How microbes in soil can help solve crimes.
The officers, in Metropolitan Police uniform, searched the grass on their hands and knees.
• Current procedures to detect clandestine graves

• Limitations of these procedures

• Ideal procedure to detect clandestine graves
No grant funding available for this research
Current techniques employed
Mobile Technology tracking .....
Current techniques employed
A fast method to locate a body in a large area of earth.....
Four main clandestine burial decompositional stages. (A) Recent burial, surface expression is most obvious. (B) Early decomposition with search dogs and/or methane probes being optimal. (C) Late-stage decomposition with grave soil fluids. (D) Final skeletonised decomposition, GPR may locate.
Is there a problem?
A famous case driven in part by the Media
An aerial image shows the ground where police first started digging in the Madeleine McCann investigation yards from the apartment where she was last seen.
Metropolitan Police – news video- latest search for Madeline McCann
Figure 61 Schematic illustration to show the influence of groundwater flows and the migration of body scent, which may be carried away from the grave site, as a leachate plume, to emerge on the flanks.

Ground Penetrating Radar (GPR)
This consists of a radar antenna transmitting electromagnetic energy in pulse form at frequencies between 25 MHz and 1 GHz. The pulses are partially reflected by the sub-surface geological structures, picked up by a receiving antenna and plotted as a continuous two-way travel time record, which is displayed as a pseudo-geological record section. The vertical depth scale of this section can be calibrated from the measured two-way travel times of the reflected events either by the use of the appropriate velocity values of electromagnetic pulse through the ground.

The depth of penetration achieved by the radar pulse is a function of both its frequency and the conductivity of the ground.
If only murders would stand there and wait to be caught.......
BBC TV COUNTRYFILE video
Thursday, 3 April 2014

Another "body farm"...in the USA

We at the Burial Research Consortium watched and listened with interest to this press release and video about a forensic taphonomy facility being built at Fox Valley Technical College in Madison, Wisconsin. The 2 acre facility is set to open in 2015, and will primarily focus on decomposition in the northeastern USA climate, including sub-zero temperatures. This represents an important development in furthering forensic taphonomy research, and will be the seventh such facility in the USA. The BRC are at the forefront of the efforts in the UK/Europe to establish a similar facility, and will watch the progress at Fox Valley closely. We wish them the best of luck with the project!

Posted by Burial Research Consortium at 07:01  No comments:
Model 1900 Soil Water Sampler

Z1900-200 Stopper Assembly
(Shows stopper, Neoprene tubing and clamping ring)
Preliminary soilwater conductivity analysis to date clandestine burials of homicide victims

Jamie K. Pringle a,*, John P. Cassella b, John R. Jervis a

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b Department of Forensic and Crime Science, Faculty of Sciences, Staffordshire University, College Road, Stoke-on-Trent, Staffordshire, ST4 2DE, UK

A B S T R A C T

This study reports on a new geoscientific method to estimate the post-burial interval (PBI) and potential post-mortem interval (PMI) date of homicide victims in clandestine graves by measuring decomposition fluid conductivities. Establishing PBI/PMI dates may be critical for forensic investigators to establish time-lines to link or indeed rule out suspects to a crime. Regular in situ soilwater analysis from a simulated clandestine grave (which contained a domestic buried pig carcass) in a semi-rural environment had significantly elevated conductivity measurements when compared to background values. A temporal rapid increase of the conductivity of burial fluids was observed until one-year post-burial, after this values slowly increased until two years (end of the current study period). Conversion of x-axis from post-burial days to ‘accumulated degree days’ (ADDs) corrected for both local temperature variations and associated depth of burial and resulted in an improved fit for multiple linear regression analyses. ADD correction also allowed comparison with a previous conductivity grave study on a different site with a different soil type and environment; this showed comparable results with a similar trend observed. A separate simulated discovered burial had a conductivity estimated PBI date that showed 12% error from its actual burial date. Research is also applicable in examining illegal animal burials; time of burial and waste deposition. Further research is required to extend the monitoring period, to use human cadavers and to repeat this with other soil types and depositional environments.

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• Putrescine and cadaverine are significant decomposition products

• Putrescine and cadaverine are potential biomarkers for analytical instrument detection of clandestine graves

• Prominent researchers did not detect these compounds in grave headspace or soil – why?
Video on How GCMS works
Giorgio video
Analysis of leachate samples

Detection of putrescine and cadaverine the leachate samples over time.
ION CHROMATOGRAPHY - AN EXAMINATION OF PORCINE LEACHATE TO IDENTIFY CHEMICAL MARKERS FOR CLANDESTINE GRAVES
Summary of the early Putrescine, Cadaverine and work

• Putrescine and cadaverine were detected in the leachate samples from 181 days up to 902 days post burial by GC-FID.

• Methylamine was also detected around this time interval.

• There is no linear relationship for the concentration of putrescine and cadaverine over time.

• Putrescine and cadaverine are less volatile if dissolved in water – so they will hang around longer in soil.
Image removed due to sensitivity
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**ANALYTICAL METHODS (1)**

**GC-MS CRANFIELD LEACHATE**

<table>
<thead>
<tr>
<th>Time</th>
<th>Methylamine</th>
<th>Cadaverine</th>
<th>Putrescine</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.59</td>
<td>7.64</td>
<td>12.10</td>
<td>9.58</td>
</tr>
<tr>
<td>4.59</td>
<td></td>
<td>10.12</td>
<td>11.18</td>
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<td>6.59</td>
<td></td>
<td></td>
<td>13.86</td>
</tr>
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<td>8.59</td>
<td></td>
<td></td>
<td>18.54</td>
</tr>
<tr>
<td>10.59</td>
<td></td>
<td></td>
<td>20.28</td>
</tr>
<tr>
<td>12.59</td>
<td></td>
<td></td>
<td>20.89</td>
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<tr>
<td>14.59</td>
<td></td>
<td></td>
<td>16.96</td>
</tr>
<tr>
<td>16.59</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18.59</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20.59</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>22.59</td>
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<td>24.59</td>
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<td>26.59</td>
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<td></td>
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<td>28.59</td>
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<td>30.59</td>
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<tr>
<td>32.59</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>34.59</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Control sample 5 weeks post burial**

**Reconstructed Ion Chromatogram:**

- **Grave sample 5 weeks post burial**
- **Total Ion Chromatogram:**
ANALYTICAL METHODS (1)
GAS CHROMATOGRAPHY MASS SPECTROMETRY (GC-MS)

• Why?
  – Analysis of decomposition markers putrescine & cadaverine

• Methodology
  – Derivatisation of amines using pentafluorobenzaldehyde
  – DB-5MS column

• Outcomes
  – Methylamine another potential decomposition marker
  – RSD < 5%
  – Methylamine \(\text{LOD}_{\text{TIC}}\) 4.2 ppb, \(\text{LOQ}_{\text{TIC}}\) 12.6 ppb
  – Putrescine \(\text{LOD}_{\text{TIC}}\) 15.9 ppb, \(\text{LOQ}_{\text{TIC}}\) 48.3 ppb
  – Cadaverine \(\text{LOD}_{\text{TIC}}\) 13.6 ppb, \(\text{LOQ}_{\text{TIC}}\) 41.3 ppb
ANALYTICAL METHODS (2)
ION CHROMATOGRAPHY (IC)

• Why?
  – Pringle 2012 demonstrated high levels of soil-water conductivity relating to the gravesite samples

• Methodology
  – AS22 Column, Carbonate / bicarbonate Eluent, $\text{H}_2\text{SO}_4$ suppressor

• Outcomes
  – Fluoride & Acetate co-elute
  – RSD < 2%
  – Acetate $\text{LOD}_{\text{TIC}}$ 5.9 ppm, $\text{LOQ}_{\text{TIC}}$ 18.2 ppm
  – Chloride $\text{LOD}_{\text{TIC}}$ 1.8 ppm, $\text{LOQ}_{\text{TIC}}$ 10.4 ppm
  – Nitrate $\text{LOD}_{\text{TIC}}$ 0.6 ppm, $\text{LOQ}_{\text{TIC}}$ 1.7 ppm
  – Phosphate $\text{LOD}_{\text{TIC}}$ 1.4 ppm, $\text{LOQ}_{\text{TIC}}$ 4.9 ppm
  – Carbonate $\text{LOD}_{\text{TIC}}$ 0.5 ppm, $\text{LOQ}_{\text{TIC}}$ 1.5 ppm
ANALYTICAL METHODS (2)
IC KEELE LEACHATE

Control sample
129 weeks post burial

Grave sample
129 weeks post burial

Courtesy of Stephanie van Rens
ANALYTICAL METHODS (2)
ION CHROMATOGRAPHY (IC)

• Why?
  – Pringle 2012 demonstrated high levels of soil-water conductivity relating to the gravesite samples

• Methodology
  – AS22 Column, Carbonate / bicarbonate Eluent, H₂SO₄ suppressor

• Outcomes
  – Fluoride & Acetate co-elute
  – RSD < 2%
  – Acetate \( \text{LOD}_{(\text{TIC})} \text{ 5.9 ppm, } \text{LOQ}_{(\text{TIC})} \text{ 18.2 ppm} \)
  – Chloride \( \text{LOD}_{(\text{TIC})} \text{ 1.8 ppm, } \text{LOQ}_{(\text{TIC})} \text{ 10.4 ppm} \)
  – Nitrate \( \text{LOD}_{(\text{TIC})} \text{ 0.6 ppm, } \text{LOQ}_{(\text{TIC})} \text{ 1.7 ppm} \)
  – Phosphate \( \text{LOD}_{(\text{TIC})} \text{ 1.4 ppm, } \text{LOQ}_{(\text{TIC})} \text{ 4.9 ppm} \)
  – Carbonate \( \text{LOD}_{(\text{TIC})} \text{ 0.5 ppm, } \text{LOQ}_{(\text{TIC})} \text{ 1.5 ppm} \)

Courtesy of Max Krens & Stephanie van Rens
CASEWORK SAMPLES A (WATER) IC

Courtesy of Vincent Voorwerk
CASEWORK SAMPLES (2)
LOCATION B

- Sample type: Soil
- Victim went missing 15 years ago
- 12 sampling locations:
  - 1 at body location
  - 3 downslope (North)
  - 2 upslope near dog indication (South)
  - 3 further upslope (including control)
  - 2 samples adjacent to the body (East & West)

- Samples taken from top and bottom of auger
- 24 samples including control samples
SOIL EXTRACTION METHODOLOGY

1a. (IC) Dry 1g soil in oven at 60°C overnight or
1b. (GC) Mix 1g soil with 1g anhydrous sodium sulphate

2. Grind sample, sieve and place in centrifuge tube

3. Add 5ml distilled water and vortex sample for 10 seconds

4. Place samples in ultrasonic bath for 15 minutes, centrifuge for 10 minutes 2500rpm and filter aliquot

5. Re-do step 3 & 4 two times
# SOIL EXTRACTION RESULTS IC

<table>
<thead>
<tr>
<th>Anion</th>
<th>Spiked (mg·L⁻¹)</th>
<th>Found (mg·L⁻¹)</th>
<th>Control (mg·L⁻¹)</th>
<th>Recovery (%)</th>
<th>RSD (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluoride</td>
<td>3.3245</td>
<td>0.9571</td>
<td>0.3005</td>
<td>19.75</td>
<td>3.0</td>
</tr>
<tr>
<td>Chloride</td>
<td>3.3245</td>
<td>0.9270</td>
<td>0.2457</td>
<td>20.49</td>
<td>2.4</td>
</tr>
<tr>
<td>Nitrite</td>
<td>3.3245</td>
<td>0.9419</td>
<td>0.4165</td>
<td>10.85</td>
<td>9.1</td>
</tr>
<tr>
<td>Nitrate</td>
<td>6.6490</td>
<td>5.9045</td>
<td>4.0984</td>
<td>17.16</td>
<td>7.9</td>
</tr>
<tr>
<td>Sulphate</td>
<td>3.3245</td>
<td>1.1875</td>
<td>0.4931</td>
<td>20.89</td>
<td>9.2</td>
</tr>
</tbody>
</table>

Courtesy of Vincent Voorwerk
CASEWORK SAMPLES B (SOIL) IC

Rotated Component Loadings

Grave

Control
Recovery

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Spiked (µg·L⁻¹)</th>
<th>Found (µg·L⁻¹)</th>
<th>Recovery %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methylamine</td>
<td>15.5</td>
<td>1.7</td>
<td>10.72</td>
</tr>
<tr>
<td>Putrescine</td>
<td>44.1</td>
<td>4.0</td>
<td>9.17</td>
</tr>
<tr>
<td>Cadaverine</td>
<td>51.1</td>
<td>3.7</td>
<td>7.32</td>
</tr>
</tbody>
</table>

Quantification

<table>
<thead>
<tr>
<th>Location</th>
<th>Putrescine (µg·L⁻¹)</th>
<th>Cadaverine (µg·L⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 AU (Grave)</td>
<td>149.2</td>
<td>&lt; LOD</td>
</tr>
<tr>
<td>6 AU (Downhill)</td>
<td>&lt; LOQ</td>
<td>&lt; LOD</td>
</tr>
<tr>
<td>8 AU (Uphill)</td>
<td>&lt; LOQ</td>
<td>&lt; LOD</td>
</tr>
<tr>
<td>12 AU (Control)</td>
<td>&lt; LOD</td>
<td>&lt; LOD</td>
</tr>
</tbody>
</table>
LABRADOR (Lightweight Analyzer for Buried Remains and Decomposition Odor Recognition)
Caylee Marie Anthony
“Jose Baez harassing Dr. Vass about the handheld "sniffer machine" nicknamed "Labrador," designed to detect human decomposition by reading such air samples. “

http://www.acandyrose.com/caylee_anthony_murder_trial_060611.htm
Casey Anthony Trial - Dr. Vass and the hamburger theory
Confoundning variables & getting the research into the Criminal Justice System
Confounding variables & getting the research into the Criminal Justice System

Trial - Dr Vass tells Baez You can't take it out of context
That Courtroom look........
UK Taphonomy facility (?)
Where to start?
The future – a simple chemistry set kit?

- SIRCHIE® Fingerprint Laboratories introduces the NARK® II Progressive System for Drug Identification. NARK® II has the capability of presumptively identifying several families of substances suspected of being abused drugs. Designed to function as a transportable narcotics laboratory, it is available for use wherever the need for its capability might arise.
The way forward.....next steps

• Continue to investigate and develop the chemistry methodology
• Continue to work within the Burial Research Consortium
• Work more closely with Police colleagues to develop and test the research further “in the field”
Thank you for listening