Detection of Buried Cadavers by Volatile Metabolites analysis

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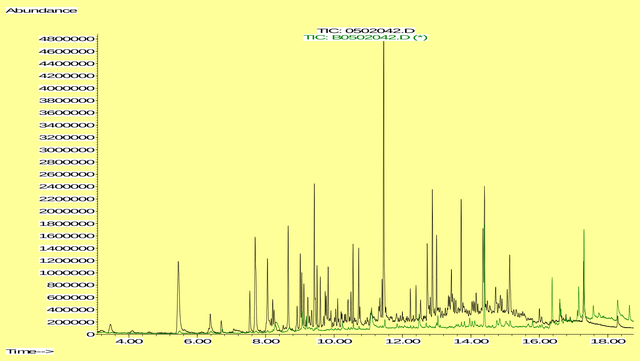
Introduction:
In the field of necrosearch, cadaver dogs are used but have limitations due to operational capability (3 times 20 minutes a day), weather conditions and vegetation. Typical odour signature of decomposition is not fully understood, neither is the structure of the molecules triggering cadaver dogs. The presented preliminary results try to identify molecules, typical for decomposition of corpses with the emphasis on human decomposition. Different phases of decomposition were monitored (from fresh tissue till skeletal remains). A method was developed to trap and identify volatile compounds in situ. Identified compounds were presented to cadaver dogs in order to pinpoint some of the reaction triggers. Finally, an attempt is made to discriminate human from animal volatile compounds.

1. Active surface sampling:
Active sampling of air with a Gillian LFS low flow pump (max flow rate 500mL/min) Sampled volatiles are adsorbed on Tenax GR tube. Tenax tubes are preconditioned with two subsequent thermal desorption cycles at 320°C (He flow of 40mL/min)

2. Active sub-surface sampling:
Active sampling by the same method as for surface sampling but with connection of a sampling probe: the stainless steel tube has an internal diameter of 1cm and a total length of 130cm. An additional connection can be added to increase the sampling depth (up to a total length of 3m).

3. Sampling probe:
The end of the probe can be drilled in the soil without blocking all the sampling holes located of the probe.

4. Analysis:
Samples are thermally desorbed with a Perkin Elmer ATD 400. Adsorbed volatiles are cold trapped and injected in an Agilent 6890N GC-MS equipped with mass spectrometric detector. A typical chromatogram is shown for a chromatographic separation on a DB5-MS capillary column. The oven program starts at 35°C followed by heating at 20°C till 220°C. Subsequently, accellerated heating untill 280°C at 60°C. Total run time is 21.25 minutes per sample. Carrier gas is He at 2.8mL/min. Splitless injection, detector in full scan mode between 32 and 550 m/z. Blank Tenax GR tubes (green chromatogram) were ran randomly in between sampled tubes (black chromatogram). Control samples (soil sampled at a distance from corpses) were treated in the same manner as other samples. Identification of compounds is performed by comparison of mass spectra with mass spectral libraries and confirmed by spectra as well as retention times of analytical standards.



5. Results:
Results are shown as the most frequent chemical functions found in either soft tissue or human femoral bone (n= 6). Results of the differences among species is shown below. A first attempt is made to discriminate between the volatile compounds produced by human decomposition against other species. These results are a basis for futher research in different types of soil and wheather conditions. The cadaver dog testing shows clear difference in the response of the animal to certain compounds. Once again, it stresses the attention of the dog handler to the importance of the compounds used during training sessions with commercial mixes.

1. Soft tissue:
   - benzene derivatives (toluene, methylbenzene)
   - sulphur compounds (disulfides)
   - nitrogen compounds (indane, indole)
   - aldehydes (nonanal, decanal)
   - acyclic hydrocarbons (C11-C14-C17)
   - cyclic hydrocarbons (see table)
   - acids and esters

2. Human femoral bone:
   - Hydrocarbons
   - Alcohols
   - Aldehydes
   - Cetones
   - Esters
   - Acids
   - Anhydrides
   - Furan derivatives
   - Benzene derivatives
   - Cyclic hydrocarbons

	HUMAN	CAT	DOG	PIG	RAT	BIRD	RABBIT
Dimethyl disulfide	X	X	X	X	X	X	X
1-R-α-pinene	X	X	X	X	X		X
3-carene	X		X		X		
1,1-dimethylcyclohexane					X		
1 methylpropylcyclohexane					X		
α-phellandrene			X				
β-phellandrene	X		X				X
β-pinene	X		X				X
Camphene	X		X				X
Limonene	X	X	X		X		X
Phenantrene	X						

Cadaver dog tests:
! blind test on single compounds !
POSITIVE: dimethyl disulfide, indole, mix, furfural, camphene

INTEREST: limonene, heptadecane

NEGATIVE:
-composition of commercial training mixes:
2-pyrrolidinone (mix 1)
2-pyrrolidinone, putrescine, cadaverine (mix 2)
-benzene derivatives, carbohydrates

Explanation of decay in detection capability: loss of soft tissue induces lowering of the concentration of dimethyl disulfide!

6. Conclusions:
The head space probe can be used for the detection of a body. The non-specific key for the location of a putrefactive event is the detection of dimethyl disulfide. Other compounds show promising results for the discrimination between animal species. In addition, selective compounds which can trigger a response in cadaver dogs have been identified: this could help in the training program of cadaver dogs.

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