Comparative Analysis of Postmortem Remains from Human and Animal Origin: Perspectives of a Future Study

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GOAL OF THE STUDY

This study will focus on the discrimination of human and animal decomposition by analysis of components that are released during the postmortem process. This comparative analysis of human and animal remains will be carried out with the ultimate goal of tracing human remains in forensic investigations.

INTRODUCTION

The decomposition process is affected by many factors: method and time of burial, corpse-specific characteristics (weight, sex, age, cause of death,…) and conditions of the resting place (temperature, pH, insect and carnivore activity, moisture, soil type,…) [1]. Microbiology plays a major role in decomposition: protozoa, fungi, aerobic and anaerobic bacteria are involved [2].

Degradation starts approximately 4 minutes after death and begins with autolysis, the breakdown of tissue by the body's own internal chemicals and enzymes (fig.1B) [2]. The second stage of decomposition, putrefaction, is characterized by the destruction of soft tissue by anaerobic micro-organisms. During putrefaction several gases (H_2S, CO_2, CH_4, SO_2, NH_3, H_2,…) are produced causing bloating of the body (fig.1C) [2]. Next, the active decay begins: the breakdown of muscle, carbohydrates and fat results in degradation products of which some are considered significant during decomposition like indole, skatole, cadaverine, putrescine and various fatty acids (fig.1D,E) [2]. In this phase formation of a grayish soap-like substance, adipocere or grave wax is observed under certain circumstances. Adipocere is formed by alteration of body fat into an insoluble lipid mixture which mainly consists of saturated fatty acids and inhibits cadaver decomposition [3]. However, this phenomenon is not fully understood yet. The final stage in degradation is diagenesis: the decomposition of the bone [2].
The four stages described here are not necessary present or may take place at the same time. Therefore, decomposition could also be segregated into pre- and post-skeletonization [2].

Fig.1: Different stages of the decomposition process: (A) living pig; (B) autolysis; (C) putrefaction; (D), (E) decay; (F) the pig is reduced to hair and bone [4].

	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
phenanthrene	X						

Table 1: Identification of specific and non-specific compounds.

One aspect of importance for forensic investigations is the odor. Trained canines have the ability to find human remains as well as an ability to discriminate between human remains and those of other mammals [5]. Certain insects can detect the smell of degradation [6]. The odor observed by a dog or an insect is thus a mix of chemical compounds which is specific for postmortem remains, and even for human remains.

Some efforts have already been made to identify these volatile substances. Besides some inorganic gases (H_2S, CO_2, SO_2, NH_3, H_2,…), the identified substances evolving from dead bodies belong to different classes of organic molecules: hydrocarbons, aldehydes, ketones, acids, alcohols, esters, aromatics and sulfides [6]. Unpublished results of Smedts *et al.* show that certain volatile compounds are species specific and one of the major differences between species has been identified in the cyclic hydrocarbons (table1).

EXPERIMENTAL SET UP

Human and animal samples will be buried in 2L erlenmeyer flasks. Analysis of the soil will be performed on a weekly basis. Therefore, extracts of this soil will be analyzed by gas chromatography coupled to mass spectrometry (GC-MS). For detection and identification of the volatile compounds, two approaches will be used. First, headspace solid-phase microextraction (HSPME) sampling followed by GC-MS analysis provides a clean and selective way to characterize the volatile compounds. For this purpose, a fiber will be immersed in the headspace of the flask (fig.2). After adsorption of decompositional gases, the fiber can be inserted in GC-MS and the adsorbed substances can be analyzed. In the second approach, a flow of helium will be used to evacuate decompositional gases from the soil into a carbon-filter (fig.2). Analysis of the substances adsorbed onto the C-filter can be performed by desorption followed by GC-MS.

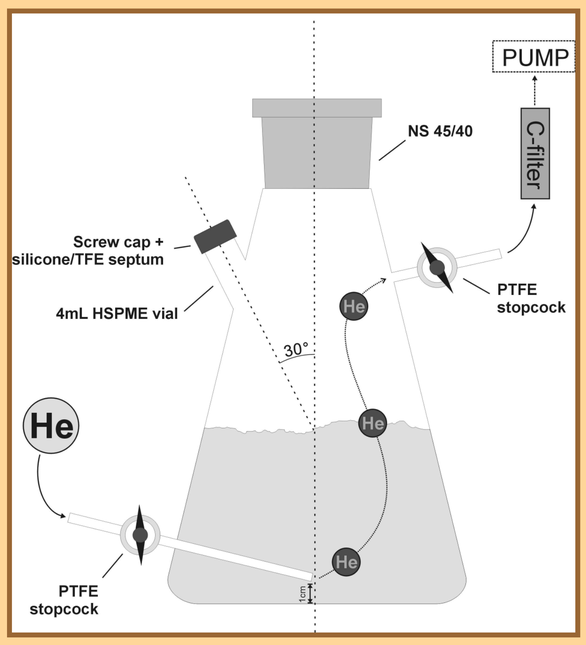

Fig. 2: The 2L erlenmeyer flask in which the postmortem remains will be buried. Voltatile compounds will be adsorbed by headspace solid-phase microextraction (HSPME) or by a carbon-filter.

SUMMARY

During the breakdown of soft tissues of the body different gases, liquids and simple molecules are produced. Identification of decomposition-specific substances would be promising for forensic investigations. Moreover, this project intends to identify postmortem biomarkers specific for humans in order to differentiate buried species.

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