UNIVERSITY OF
CHEMISTRY AND TECHNOLOGY
PRAGUE

FORENSIC OLFACTRONIC

The First International workshop on

Chemical Analysis of Human Scent for Forensic Purposes

Prague, Czech Republic
September 22 - September 23, 2022

FORENSIC OLFATRONICS
The first First International workshop on
Chemical Analysis of Human Scent
for Forensic Purposes

is organized by
the University of Chemistry and Technology, Prague

UNIVERSITY OF
CHEMISTRY AND TECHNOLOGY
PRAGUE

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Czech Republic

MINISTRY OF THE INTERIOR
OF THE CZECH REPUBLIC

Book of abstracts

of the First International workshop
on Chemical Analysis of Human Scent
for Forensic Purposes

Edited by Š. Urban, V. Škeříková, P. Pouzarová, and T. Uhlíková

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Prolog

The international workshop 'Chemical Analysis of Human Scent for Forensic Purposes' is organized with an essential aim to establish a scientific community in the forensic olfactronics. Such a community should be supporting collaborations between particular groups and in this way accelerating olfactronic research.

We believe that this workshop should be a first step towards building an international network of researchers and practitioners capable of bringing new olfactronic methods into forensic work, respectively police practice. Thus, it is primarily a detailed chemical analysis of human odor. This work includes the choice of a sorbent for odor collection, collection methodology for both laboratory studies and police practice, i.e., at the crime scene. Special attention will be paid to the digitization of odor samples, the search for the so-called 'odor signatures' in digital form and, of course, the creation of a database of odor signatures, which can significantly expand the possibilities of individual odor identification.

In principle, forensic olfactronics also enables the acquisition of additional information about the person who left the scent trail. Our analyzes show that, within the framework of so-called group identification, the scent trace enables the determination of gender, blood group, ethnic origin (distinguishing Europeans from Asians, Blacks, Indians, etc.), Rh-factors, and a number of other characteristics of an individual.

Developing an objective method of measuring individual human scent and digitizing the information would constitute a significant advance for forensic science and police practice. Human scent would join fingerprints, DNA and other biometric information as a marker by which persons of interest (criminals, crime victims, missing persons, etc.) could be identified. Courts would have a new, significant tool at their disposal to make judgements in criminal proceedings, while innocent persons could be cleared of guilt based on the comparison of their scent signature with that found at the crime scene.

Attendees

Rashid Alghafri
Director of the International Centre for Forensic Science
Dubai, United Arab Emirates

Hessa Altamimi
International Centre for Forensic Science
Dubai, United Arab Emirates

Emilynn Banks
Texas Tech University
Lubbock, TX, USA

Vincent Cuzuel
Institut de Recherche Criminelle de la Gendarmerie Nationale
Paris, France

Lauryn DeGreeff-Silk
Florida International University
Miami, Florida, USA

Jiří Drábek
Palacký University Olomouc
Olomouc, Czech Republic

Barbara Ferry
Centre de Recherche en Neurosciences de Lyon
Lyon, France

Kenneth G. Furton
Florida International University
Miami, Florida, USA

Jan Halámek
Texas Tech University
Lubbock, TX, USA

Orsolya Horváth
University of Pécs
Pécs, Hungary

Lorna Irish
Defence Science and Technology Laboratory
Salisbury, United Kingdom

Sunil Kr. Jha
Adani University,
Ahmedabad, Gujarat, India

Dustin Penn
Konrad Lorenz Institute of Ethology
Vienna, Austria

Radim Pernický
Police presidium of the Czech Republic
Prague, Czech Republic

Ludvík Pinc
Canine Behavior Research Center, Czech University of Life Sciences Prague
Prague, Czech Republic

James Reynolds
Loughborough University
Loughborough, United Kingdom

Isabelle Rivals
Applied Statistics Team (ESA), École Supérieure de Physique et de Chimie Industrielles de la Ville de Paris
Paris, France

Norman Ratcliffe
University of the West of England
Bristol, United Kingdom

Richard Sehnal
Police presidium of the Czech Republic
Prague, Czech Republic

Vladimír Táborský
Police presidium of the Czech Republic
Prague, Czech Republic

Didier Thiebaut
Analytical and Bioanalytical Sciences and Miniaturization, École Supérieure de Physique et de Chimie Industrielles de la Ville de Paris
Paris, France

Prague Olfactronic Team

Štěpán Urban (head)

Profesor Assistents
Veronika Škeříková
Petra Pojmanová

PhD Students
Nikola Ladislavová
Jana Čechová
Oleksii Kaminskyi
Ulrika Malá

Aknowledgement

The workshop was supported by the project "The formation of an international comunity in the field of Forensic olfatronic" (number VJ01030005) of the Ministry of Interior of Czech Republic.

Program of sessions

9:30 Thursday – 18:30 Friday

Wellcome Session **Tuesday, 9:30– 10:15**

Urban Š. 9:30
Wellcome Word

Táborský V. 9:45
Wellcome Word by a Representative of the Police of the CR

Pinc L. 10:00
Olfactoric and Olfactronic – Why is Olfactronic Desirable?

Coffee Break **Tuesday, 10:15–10:45**

Prague Olfactronic Team Session **Tuesday, 10:45–11:30**

Kaminskyi O. 10:45
Čechová J., Ladislavová N., Malá U., Pojmanová P., Škeříková V., Urban Š.
Portable Device for Contactless Scent Sampling

Ladislavová N. 10:55
Kaminskyi O., Čechová J., Urban Š.
Automation of Scent Data Processing: From Chromatograms to Result Reports

Pojmanová P. 11:05
Ladislavová N., Urban Š.
Group Identification: Differences between Men and Women

Malá U. 11:15
Čechová J.,Kaminskyi O., Ladislavová N., Pojmanová P., Škeříková V., Urban Š.
Group Identification: Differences between Races

Čechová J. 11:25
Kaminskyi O., Malá U., Ladislavová N., Pojmanová P., Škeříková V., Urban Š.
Group Identification: Differences between Blood Types

Paris Session **Tuesday, 11:30–12:15**

Cuzuel V. 11:30
Cognon G.
The Olfactory Approach: From Scent Dogs to Scent Chemical Analysis

Thiebaut D. 11:45
Boudard E., Dugay J., Rivals I., Vial J.
Body Odor Sampling and Unwanted Emissions of Sampling Devices

Rivals I. 12:00
Sautier C., Cognon G., Cuzuel V.
Optimization of Distance-based Approaches for Individual Identification Using GCxGC-MS Characterization of Hand Odor

Lunch Break **Tuesday, 12:15–13:45**

International Session **Tuesday, 13:45–15:30**

Jha S. Kr. 13:45
Human Body Odor Data Mining

Penn D. 14:00
Introductory Presentation on the Olfactronic Activities ofKonrad Lorenz Institute of Ethology, Vienna

Ferry B. 14:15
Kormos L., Bakondyné S., Less F.
Human Scent Matching-to-sample Performance in Dogs using a New Sorbent

Reynolds J. C. 14:30
Rapid In-Situ Analysis of Volatile Organic Compounds from Dried Biofluids

Irish L. 14:45
Introductory Presentation on the Olfactronic Activities ofthe Defence Science and Technology Laboratory DSTL, Salisbury

Ratcliffe N. 15:00
Honeychurch K.
A Literature Survey of Volatiles from Human Breath and Bodily Fluids: The Human Volatilome and Its Potential Use in Forensic Science

Alghafri R. 15:15
Altamimi H.
Detection of Human Scent for Forensic Applications

Coffee Break **Tuesday, 15:30–16:00**

International Session **Tuesday, 16:00–17:15**

Horváth O. 16:00
Collecting Scent Samples at the Crime Scene

Furton K. G. 16:15
Gokool V., Boone A., Crespo-Cajigas J.
Advances in the Use of Human Scent as a Classifier, Identifier, and Marker of Disease

DeGreeff L. E. 16:30
Whaley F., Perry E.
Further Olfactronic Activities at Florida International University: Living vs. Remains Scent

Halámek J. 16:45
Non-Invasive Metabolite Monitoring Concept for Individual Profiling

Banks E. 17:00
Halámek J.
Transitions from Sweat Identification Methods to Novel Odor Identification Methods

Dinner **Tuesday, 19:00**

Open discussions **Friday, 9:30-10:45**

Methods of Scent Collection and Preparation of the Samples 9:30

The Individual Identification of Persons I 10:15

Coffee Break **Friday, 10:45–11:15**

Open discussions **Friday, 11:15-12:00**

The Individual Identification of Persons II 11:15

Lunch Break **Friday, 12:00–13:30**

Open discussions **Friday, 13:30–15:30**

Class Identification of Persons 13:30

Digitization of Scent Signatures and Their Database 14:30

Coffee Break **Friday, 15:30–16:00**

Open discussions **Friday, 16:00-17:30**

Other Topics 16:00

Creation of an International Olfactronic Community 16:45

Dinner **Friday, 18:00**

Abstracts

Portable device for contactless scent sampling

Oleksii Kaminskyi, Jana Čechová, Nikola Ladislavová, Ulrika Malá, Petra Pojmanová, Veronika Škeříková, Štěpán Urban

Department of Analytical Chemistry, Faculty of Chemical Engineering,
University of Chemistry and Technology, Prague, Czech Republic, kaminsko@vscht.cz

The development of the device for contactless collecting of human scent was based on a commercial vacuum cleaner.
The number of sorbent layers, the volume flow of air passing through the sorbent, and the distance from the sample surface are the parameters that have been tested. The influence of the excitation by infrared radiation and the sampling duration has also been tested. For this purpose, the commercial vacuum cleaner was supplemented by parts, which provide the required airflow and the IR radiation source fixation, made of polylactic acid filaments by means of a 3D printer.
Optimized sampling parameters were based on the recovery of three chosen chemical compounds from different groups of organic compounds.

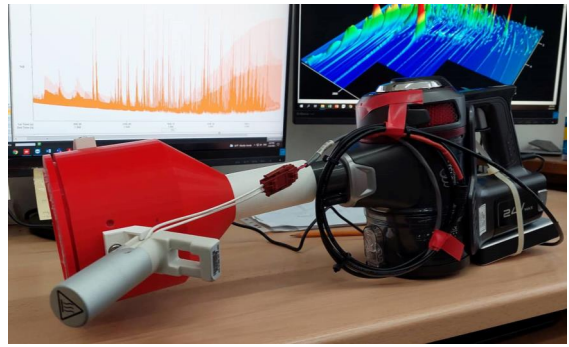

Fig. 1: Portable device for contactless scent sampling.

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[1] O. Kaminskyi: *Master thesis.* University of Chemistry and Technology, Prague, Prague, Czech Republic, 2021

Scent data processing automation: from chromatograms to result report

Nikola Ladislavová, Oleksii Kaminskyi, Jana Čechová, Štěpán Urban

Department of Analytical Chemistry, Faculty of Chemical Engineering,
University of Chemistry and Technology, Prague, Czech Republic, ladislan@vscht.cz

The main topic of the presentation was the sketching of steps needed for the unification and automation of the two-dimensional chromatographic scent data processing. First, data alignment is needed, so data can be shared among laboratories engaged in scent research; this step improves the effectiveness of resources, both instrumental and human. Then, key functions of the data cleaning pipeline and data preparation were proposed. Afterward, the possibility of applying machine learning approaches was suggested. This point is crucial for building up the final aspect of automation aspect, Human Scent Database. The prototype of such a database was introduced to the audience. The main goal of all discussed steps in the process is to reduce the wasting of resources ingaged in research activities, allow data to be shared easily, and sketch the unified automated methodology for handling the human scent data.

Human Skin Scent: Class and Individual Identification

Petra Pojmanová, Nikola Ladislavová, Štěpán Urban

Department of Analytical Chemistry, Faculty of Chemical Engineering, University of Chemistry and Technology, Prague, Czech Republic, petra.pojmanova@vscht.cz

In this work, a total of 504 human scent samples of 40 people (20 women and 20 men) were taken and analyzed using comprehensive two-dimensional gas chromatography with mass spectrometry (GC×GC-MS). The aim of this work was to find trends in the representation of monitored compounds in human scents in connection with sex and to create classification models, which were able to correctly assign sex with the greatest possible probability (class identification). A total of 70 pre-selected compounds were monitored. Various multi-dimensional methods were used for this purpose, namely principal component analysis (PCA), orthogonal partial least squares discrimination analysis (OPLS-DA), quadratic discriminant analysis (QDA), and the supporting vector machine (SVM). In addition, classification models were subsequently sought, which would be able to assign the scent sample to a specific volunteer with the greatest possible accuracy (individual identification). Models based on SVM with a polynomial kernel function were ranked best. Within the framework of sex differentiation, the model created from all (504) measured scent samples achieved a validation accuracy of over 91%, and the SVM model for individual identification achieved a validation accuracy of over 73 %

Class identification: Differences between races

Ulrika Malá, Jana Čechová, Oleksii Kaminskyi, Nikola Ladislavová, Petra Pojmanová, Veronika Škeříková, Štěpán Urban

Department of Analytical Chemistry, Faculty of Chemical Engineering, University of Chemitry and Technology Prague, Czech Republic, malau@vscht.cz

In this preliminary study, samples from the 65 volunteers were collected – 19 Mongoloids (15 Vietnamese, 4 Indian), 4 Negroids, and 42 Europoids. Differences between races were examined in three separate studies. In the case of differences between Vietnamese and Europoids, it was possible to assign volunteers to the group with a success rate of 95% by using the Nearest Neighbor data mining method. In the case of differences between Indians and Europoids, the samples can be divided into two groups. The samples of Negroid and Europoid volunteers are only slightly different.

References

[1] K. Kroutilová: Bachelor thesis. University of Chemistry and Technology, Prague, Prague, Czech Republic, 2020

[2] K. Kroutilová: Master thesis. University of Chemistry and Technology, Prague, Prague, Czech Republic, 2022

[3] V. Satpal: Master thesis. University of Chemistry and Technology, Prague, Prague, Czech Republic, 2020

[4] M. Greplová: Bachelor thesis. University of Chemistry and Technology, Prague, Prague, Czech Republic, 2021

Class identification: Differences between blood types

Jana Čechová, Oleksii Kaminskyi, Ulrika Malá, Nikola Ladislavová, Petra Pojmanová, Veronika Škeříková, Štěpán Urban

Department of Analytical Chemistry, Faculty of Chemical Engineering, University of Chemistry and Technology Prague, Czech Republic, cechovaa@vscht.cz

In the first part of this study, the effect of the blood type (within the AB0 blood types system) on the scent was studied. Differences between blood type A and 0, which were visually observed, were also confirmed by statistical analysis.
In the second part, the effect of the Rh factor was studied. Particularly in the case of blood type 0, differences between Rh factors were found. Volunteers who knew their Rh factors were divided into two groups according to their positive or negative Rh factor. There was also one volunteer, who was not informed of his Rh factor. Using statistics, this volunteer was assigned to the group of Rh-negative.

References

[1] F. Brom: Bachelor thesis. University of Chemistry and Technology, Prague, Prague, Czech Republic, 2021.
[2] E. Mulenková: Bachelor thesis. University of Chemistry and Technology, Prague, Prague, Czech Republic, 2022.

The olfactory approach: from scent dogs to scent chemical analysis.

Vincent Cuzuel[1], Guillaume Cognon[1]

[1]*Institut de Recherche Criminelle de la Gendarmerie Nationale, France,*
Vincent.cuzuel@gendarmerie.interieur.gouv.fr

From a forensic point of view, dogs are able to follow trails of people using their odor. However, canines lack probative value in front of courts. Therefore, the forensic science Institute of the French Gendarmerie (IRCGN) attempts to develop an analytical strategy to characterize human odor print which could complement the information provided by dogs.
First, a direct contact sampling method with a polymeric adsorbant phase will be presented. Then, recent developments on a patented indirect (without contact) sampling device will be displayed. This new device employs the same polymeric phase and allows to sample in triplicate. Multiple experiments were carried out with dogs' handlers and demonstrated that this polymeric adsorbant was suitable for dogs' use additionally to laboratory analysis. Within the framework of this project, a panel of more than 600 people was constituted using the direct sampling method, and more than 2000 bidimensional chromatograms were obtained to investigate the odorprint of individuals.
Studies were carried out both on specific volatile organic compounds and on raw data extracted from the analyses by comprehensive gas chromatography and mass spectrometry. An overview of the statistical data processing will be presented with a focus on the current restraints regarding data variability.

References

[1] V. Cuzuel, E. Portas, G. Cognon, I. Rivals, F. Heulard, D. Thiébaut, J. Vial, *Analytical and Bioanalytical Chemistry* **409** 5113–5124, 2017
[2] V. Cuzuel, R. Leconte, G. Cognon, D. Thiébaut, J. Vial, C. Sauleau, I. Rivals, *J. Chromatogr. B.* **1092** 379/385, 2018
[3] I. Rivals, C. Sautier, G. Cognon, V. Cuzuel, *Journal Forensic Sci.* **66**, 2021

Body odor sampling and unwanted emissions of sampling devices

Elsa Boudard[1,2], José Dugay[1], Isabelle Rivals[3], Jérôme Vial[1], Didier Thiebaut[1]

[1]UMR CBI CNRS-ESPCI Paris, LSABM, ESPCI Paris, PSL Research University, Paris, France, Didier.Thiebaut@espci.psl.eu; [2]SenseDetect Health-Care, Aigremont, France; [3]Équipe de Statistique Appliquée, ESPCI Paris, PSL Research University, Paris, France

Our group is involved in odor analysis for health monitoring. To analyze human odor, a sampling system is being developed to allow a subsequent detailed monitoring of the collected compounds by Thermodesorption hyphenated to comprehensive two-dimensional chromatography - time-of-flight mass spectrometry (TD-GCxGC/ToFMS). GCxGC has been preferred to GC because it provides much higher peak capacity and better sensitivity for the analysis of such a complex matrix. For sampling, a sorbent is used to trap the volatile compounds emitted by the body similarly to Solid Phase Extraction.

This short presentation will be devoted to the optimization of the sampling system, including the sorbent, the support and the fastening system used to secure the sampling system on the body. The goal of this communication is to illustrate the problems related to the compounds emitted by the components of the "sampler" and their consequences on the very sensitive TD-GCxGC/MS analysis performed subsequently.

Optimization of distance-based approaches for individual identification using GCxGC-MS characterization of hand odor

Isabelle Rivals[1], Cédric Sautier[2], Guillaume Cognon[2], Vincent Cuzuel[2]

[1]Équipe de Statistique Appliquée, ESPCI Paris, PSL Research University, UMRS1158, France, isabelle.rivals@espci.fr; [2]Institut de Recherche Criminelle de la Gendarmerie Nationale, France

Individuals being characterized by their hand odor using a GCxGC-MS based procedure[1,2], the forensic issue of distinguishing, given two odor traces, between the same source/individual (SS) and different source (DS) hypotheses would usually be tackled by estimating a likelihood ratio (LR), the ratio of the joint probability of the two traces under the SS and DS hypotheses. For biometric traces represented by high dimensional vectors (here 741), the LR estimation is often simplified by replacing the joint probability of the two traces by that of a scalar distance between traces, but at the cost of a severe loss of information. We show that using a vectorial distance instead of a scalar one i) naturally limits the information loss, ii) is computationally tractable if the LR estimate is obtained indirectly and robustly by logistic regression, and iii) results in significantly improved identification results, as shown on a panel of 534 subjects and their 1690 odor traces[3].

However, though optimized, this approach answers the question whether two traces originate from a common source or from different sources, not whether a trace of questioned origin stems from a specific suspect source, from which one or more traces can be obtained. The way to adapt the proposed approach to the specific source question, given the inherent constraints of hand odor sampling and the characteristics of odor traces, will be opened to further discussion.

References

[1] V. Cuzuel, E. Portas, G. Cognon, I. Rivals, F. Heulard, D. Thiébaut, J. Vial, *Anal. Bioanal. Chem* **409** 5113-5124, 2017

[2] V. Cuzuel, G. Cognon, I. Rivals, F. Heulard, D. Thiébaut, J. Vial, *J. Chromatogr. A.* **1536** 58-66, 2018

[3] I. Rivals, C. Sautier, G. Cognon, V. Cuzuel, *J. Forensic Sci.* **66**, 2021

Human body odor data mining

Sunil Kr. Jha

Adani University, Ahmedabad, Gujarat, India, sdrsunil76@gmail.com

The odor is the characteristic and alarming aroma of the human body. It is a significant information source of an individual's unique characteristics and physical condition in biometric, forensic and medical applications. Due to a complex combination of VOCs, the identification of individuals on the basis of body odor by conventional instruments is a tough task. The objective of the present research talk is to introduce the data fusion and human body odor and to demonstrate research results related to the search for an optimal subset of VOCs in body odor, which can produce differentiation in an individual by using the combination of analytical methods and chemometric analysis. Specifically, the implementation of data fusion approaches to search for discriminating biomarker volatile organic chemicals (VOCs) in body odor for individual differentiation will be demonstrated. Also, some novel approaches to decision-level data fusion will be discussed in human body odor mining. Gas chromatography-mass spectrometry (GC–MS) characterized human body odor samples have been used in the analysis and validation of all experiments.

Human scent matching-to-sample performance in dogs using a new sorbent

Barbara Ferry[1], Lazlo Kormos[2], Sylvia Bakondyné[2] and Ference Less[2]

[1]Center of Research in Neuroscience Lyon, Université Claude Bernard Lyon 1, barbara.ferry@cnrs.fr; [2]Dog Handler Training and Animal Care Department of the Police Education and Training Center, Dunakeszy, Hungary.

Human scent identification is based on a matching-to-sample task in which trained dogs are required to compare a scent sample collected from an object found at a crime scene to that of a suspect. Based on dogs' greater olfactory ability to detect and process odors, this method has been used in forensic investigations to identify the odor of a suspect at a crime scene. Previous work has shown that when trained rigorously, dogs are able to detect and identify human scent with an excellent reliability and reproducibility. However, this high level of accuracy is challenged by magistrates that frequently don't consider the results obtained during human scent matching to sample tests as reliable piece of evidence during a trial.

The present work is aimed at developing a new strategy consisting in analyzing the volatile organic compounds (VOCs) of selected scent samples that have been previously identified by dogs as belonging to the same person during a matching to sample test. To this aim, hand scents of 80 adult (aging 40-56 years ; 20 females ; 60 males) individuals were collected on the polymer sorbent (SorbStar®) and served during a matching to sample task. Analysis of the data obtained in five expert dogs from Dunakeszy training center (Hungary) during the identification task showed that, after 2 days of training, dogs are able to detect and identify human scents collected on SorbStar. Data also showed that dogs can match two scents even though samples were collected at time intervals up to 6 months. These encouraging preliminary data demonstrate that dogs can detect human scents collected on SorbStar. They confirm the possibility to use the samples that have been identified by dog for chemical analyses in order to characterize the human scent profile and more precisely the VOCs commonly found in two different samples representing the primary scent.

Rapid In-Situ Analysis of Volatile Organic Compounds from Dried Biofluids.

James C. Reynolds[1]

[1] *Centre for Analytical Science, Department of Chemistry, Loughborough University, Loughborough, United Kingdom, j.c.raynolds@lboro.ac.uk*

Forensic analysis of human biological fluids detected at crime scenes is a time-consuming, destructive and costly process. In recent years the UK's Home Office has stressed the need for the development of on-site analysis methods to alleviate these issues. The ability to both identify and estimate the age of a biological fluid stain is a matter of great importance for the scientific community as existing presumptive tests used for body fluid identification are often unreliable and can be destructive to the sample. The development of rapid, non-destructive sample analysis methods could resolve many of the current problems associated with forensic body fluid analysis.

A novel handheld sampling device has been developed to enable the rapid, *in-situ* analysis of biofluids.[1] The Desorption of Surface (DoS) probe applies a heated N_2 gas stream to the sample surface in order to thermally desorb volatile organic compounds (VOCs) which can then be extracted into a suitable analyser. The probe has been coupled to a deployable mass spectrometer (CMS) (Advion Expression Compact Mass Spectrometer) and a portable aspirating ion mobility spectrometer (AIMS) (Environics Chempro) and applied to the direct analysis of human biofluids, including blood, saliva, urine, semen, and fingerprints. Biofluids were deposited and sampled directly using the probe after being stored for varying lengths of time to assess whether biofluids of different ages could be distinguished, analysis required no prior sample preparation and could be conducted rapidly within < 2 minutes. Principal component analysis (PCA) was used to construct models to differentiate between body fluids.

The mass spectrometry-based method was shown to be able to distinguish between all biofluids tested and separate them from visually similar interferants with 100% accuracy. Biofluids aged for different time periods between 0 days and 2 months were separated from each other using the PCA model developed, and potential marker ions identified which could be used indicate the age of the blood spot or fingerprints tested. The changes in the VOC profile of the biofluids are believed to be due to a combination of VOC loss with time, breakdown of labile components in the biofluids, and the production of new volatiles by bacterial action. The AIMS method lacked the resolution of the MS method and cannot identify potential marker ions, however despite the limited resolution of the instrument it proved capable of separating individual biofluids from each other and resolving different blood spots that had been deposited for different time periods, demonstrating the potential of rugged, ion mobility systems that can be used in a field setting.

References

[1] S. Rankin-Turner, M. A. Turner, P. F. Kelly, R. S. P. King, J. C. Reynolds, *Chem. Sci*, **10**, 1064, 2019

A literature survey of volatiles from human breath and bodily fluids: The human volatilome and its potential use in forensic science

Norman Ratcliffe, Kevin Honeychurch

Dept Applied Sciences, University of the West of England, Bristol, UK, Norman.Ratcliffe@uwe.ac.uk

The measurement of volatile compounds, or indeed semi-volatile compounds from a crime scene, or from a person could have applications in forensics science, these volatiles could arise from the body or by being adorned e.g. by use of perfumes etc.
Recently we have reported 1846 volatile organic compounds (VOCs) identified from healthy humans. In total over 900 additional VOCs have been reported since a 2014 review and the VOCs from semen have been added. The numbers of VOCs found in breath and the other bodily fluids are: blood 379, breath 1488, faeces 443, milk 290, saliva 549, semen 196, skin 623 and urine 444. The compounds have been included in a single table with the source reference(s) for each VOC. VOCs have also been grouped into tables according to their chemical class or functionality to permit easy comparison. Some clear differences are observed, for instance, a lack of esters in urine with a high number in faeces and breath. However, the lack of compounds from matrices such a semen and milk compared to breath for example could be due to the techniques used or reflect the intensity of effort e.g. there are few publications on VOCs from milk and semen compared to a large number for breath. The large number of volatiles reported from skin is partly due to the methodologies used. It is the authors' intention that this work will be a useful database of VOCs listed in the literature for potential forensic science application. The volatile profile of humans could change in states of disease or for dietary reasons and drinking alcoholic beverages is a case in point. This will be discussed in the Prague forensic science meeting.

Application of head space gas chromatography mass spectrometry (HS-GCMS) to determine fragrances transferred between fabrics with varying force of contact

Kevin Honeychurch

Dept. Applied Sciences, University of the west of England, Bristol, UK

In recent years, offenders have become more forensically aware; leading to the need for the development of new and novel evidence types. One such potential evidence type that we believe deserves further investigation is that of fragrance transfer. Locard's principle states that "every contact leaves a trace"; demonstrating the possible two-way transfer of evidence, from the offender to the crime scene, and vice versa. As fragrance is commonly worn by many individuals, it allows for the potential transfer from an individual to another, demonstrating close contact or their presence at a specific location. However, to date only a small number of studies have been made into the possibility of utilising fragrance as trace evidence in this way. Our present study has investigated the possible application of headspace gas chromatography mass spectrometry (HS-GC/MS) to identify the trace transfer of fragrance for one fabric sample to another. We have investigated the effect of pressure on the transfer of the fragrance from its source. The effect of application time was also studied.

It was found possible to readily identify different fragrances, hand sanitisers and toiletries from each other from the chromatographic profiles. The magnitude of the fragrance response was found to follow a log linear relationship with time. The effect of pressure was found to increase the transfer of the fragrance from one fabric to another. It was concluded that HS-GC/MS was able to determine the presence of fragrance on fabric and its transfer. Analysis of the fabric showed a correlation with both time after application and with the pressure of contact. It is concluded this could allow for the development of a new application in the forensic sciences.

Detection of Human Scent for Forensic Applications

Rashid Alghafri[1], Hessa Altamimi[1]

[1]*International Centre for Forensic Science Dubai Police, United Arab Emirates, Corresponding Author hessa.jmt@gmail.com*

The identification of humans through their scent is a promising potential field for forensic applications. An attempt was made in following a methodology presented in a paper published by Dr. Furton and his research group [1]. Unfortunately, no results were obtained after several trials. For an attempt of better results, the same methodology was then altered by changing some parameters such as the gain factor, rate of increasing temperature as well as the reduction of the initial temperature. Having done that, some volatile organic compounds (VOC) were detected; however, not as much as expected from the study. An alternative method should be developed to enhance the results as well as capitalise on the unique scent between individuals.

References

[1] Brown, J.S. et al., 2013. Applicability of emanating volatile organic compounds from various forensic specimens for individual differentiation. *Forensic Science International*, 226(1-3), pp.173–182.

Collecting scent samples at the crime scene

Orsolya Horváth

Szentágothai Research Centre, University of Pecs, Pecs, Hungary, Horvath.Orsolya@pte.hu

In Hungary, scent identification line-up was performed since the seventies. This type of personal identification is conducted by a specialized police canine, with the cooperation of the dog-handler. According to the current national legislation, scent identification line-up is a judicial procedure, while the scent collected from the crime scene is trace evidence.

The searching method of the perpetrator's scent at the crime scene is not definitely. The Hungarian directive is simple: collecting the scents from the crime scene where they could find huge quantity. Solving the task, criminal technicians or dog handlers must use the method of theoretical reconstruction.

To this day, the scent identification line-up process acts as a black box in which we do not know exactly what the dog is working on. In parallel with technological advances, the human olfactory map is being developed.

In this presentation, the results of a rudimentary odour analysis conducted in a domestic setting also represented.

Further Olfactronic Activities at Florida International University: Living vs. Remains Scent

Lauryn E. DeGreeff[1], Fantasia Whaley[1], Erin Perry[2]

[1]Florida International University, Global Forensic and Justice Center, United States, ldegreef@fiu.edu; [2]Southern Illinois University, Animal Science Food and Nutrition, United States

Florida International University, Global Forensic and Justice Center has a rich history in human scent analysis for both living and deceased scents. Similarities and differences in the collection and analysis of both types of scents will be discussed. Furthermore, in a scenario where a missing person has died in an unknown location, an odor plume from human decomposition develops in the area of and overlapping with the scent trail from the living human. This presentation will discuss preliminary research examining the transition from a living scent volatile profile to that of remains odor using headspace analysis by solid phase microextraction (SPME) with GC/MS. Anecdotally, a cadaver dog can detect the presence of human decomposition in as little as one hour after death; though, the limited analytical research in this field suggestions that a detectable odor shift does not occur for approximately 24 hours.[1] This presentation will discuss early work assessing the change in odor from living to deceased using blood as a surrogate biological material, and will then consider future plans to expand this research using animal surrogates and eventually human bodies.

References

[1] L. Rust, K.D. Nizio, S.L. Forbes, *Anal. Bioanal. Chem.* **408**, 6349, 2016.

Advances in the Use of Human Scent as a Classifier, Identifier, and Marker of Disease

Kenneth G. Furton, Vidia Gokool, Alice Boone, Janet Crespo-Cajigas

Florida International University, Global Forensic and Justice Center, Miami, Florida, USA, furtonk@fiu.edu

Human scent expression is the result of a complex mixture of genetic and environmental factors spanning the gamut of class factors such as race, ethnicity, age, sex, and gender. This presentation discusses the investigative uses of human scent as a potential predictor of these class groupings, as well as a biometric for forensic identification, and an avenue for the metabolic expression of disease. An example of class discrimination is shown in Figure 1 where groupings were observed for African American vs. Hispanic individuals. The proposed model shows that samples from African American subjects exhibit a higher average amount of 1-octadecane and dodecanoic acid.

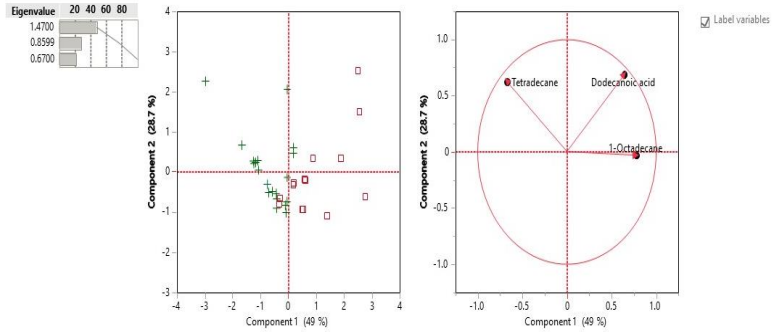

Fig. 1: PCA of Hispanic vs. African American subjects using VOCs of interest predicted via logistic regression

The use of human scent as a biometric expands upon the concept of human scent as a detectable, individualizing feature that is commonly implemented to associate an individual with an object, location, or path of travel. This utility of human scent has been built upon to establish a foundational framework for the instrumental analysis and association of human hand odor samples, using headspace-solid phase microextraction-gas chromatography-mass spectrometry (HS-SPME-GC-MS).

Within the topic of human scent metabolomics, the detection of Covid-19 status using analytical instrumentation and the development of computational models to perform human scent association will be discussed. These approaches are informed by HS-SPME-GC-MS analysis of body odor samples and demonstrate recent examples of biosensors informing the development of synthetic sensor technology. These works highlight the wide range of uses human scent poses as a form of forensic evidence and as a noninvasively collected diagnostic sample medium.

Non-Invasive Metabolite Monitoring Concept for Individual Profiling

Jan Halámek[1]

[1]*Institute of Forensic Science, Department of Environmental Toxicology, Texas Tech University, USA, jan.halamek@ttu.edu*

The research group of Dr. Jan Halámek at Texas Tech University is experienced in developing a range of bioassay detection methods and integrated, noninvasive biosensors for the detection of metabolites in sweat. These sensing methods have proven significant in the identification of individuals based on ability to demonstrate unique differences between individual's expression of metabolites in sweat. These methods have provided valuable information for forensic and security applications, revealing identifying information such as the individual's sex, ethnicity, age, diet, time since deposition of fingerprints, and can differentiate between individuals.
These techniques were advanced and made capable of detecting THC and ethanol from skin surface sweat, a significant development that proves enormous value in law enforcement. Halámek now seeks to advance these detection methods by extending into gas-phase sensing of sweat odor profiles to incorporate these same identifiers and to extend the capability of his already sensitive sensors. This work includes the use of electrochemical and optical sensing devices to further his work into the fields of olfactronic group identification.

Halámek Research Lab Transitions from Sweat Identification Methods to Novel Odor Identification Methods

Emilynn Banks[1], Dr. Jan Halámek[1]

[1]Texas Tech University, Institute for Forensic Science, Lubbock, TX, USA

emilynn.banks@ttu.edu / jan.halamek@ttu.edu

The research group of Dr. Jan Halámek at Texas Tech University is experienced in developing a range of bioassay detection methods and integrated, noninvasive biosensors for the detection of metabolites in sweat. These sensing methods have proven significant in the identification of individuals based on ability to demonstrate unique differences between individual's expression of metabolites in sweat. These methods have provided valuable information for forensic and security applications, revealing identifying information such as the individual's sex[1], age[2], substance use[3,4], time since deposition of fingerprints[5], and can differentiate between individuals[6,7].

These techniques were advanced and made capable of detecting THC and ethanol from skin surface sweat, a significant development that proves enormous value in law enforcement. Dr. Halámek now seeks to advance these detection methods by extending into gas-phase sensing of sweat odor profiles to incorporate these same identifiers and to extend the capability of his already sensitive sensors. This work includes the use of electrochemical and optical sensing devices to further his work into the fields of olfactronic group identification.

References:

[1] A. I. Mekkaoui, J. Halamek, *J Forensic Sci*. **64**(5), 1495-1499, 2019

[2] J. Agudelo, L. Halámková, E. Brunelle, R. Rodrigues, C. Huynh, J. Halámek, *Anal Chem*. **88**(12), 6479-6484, 2016

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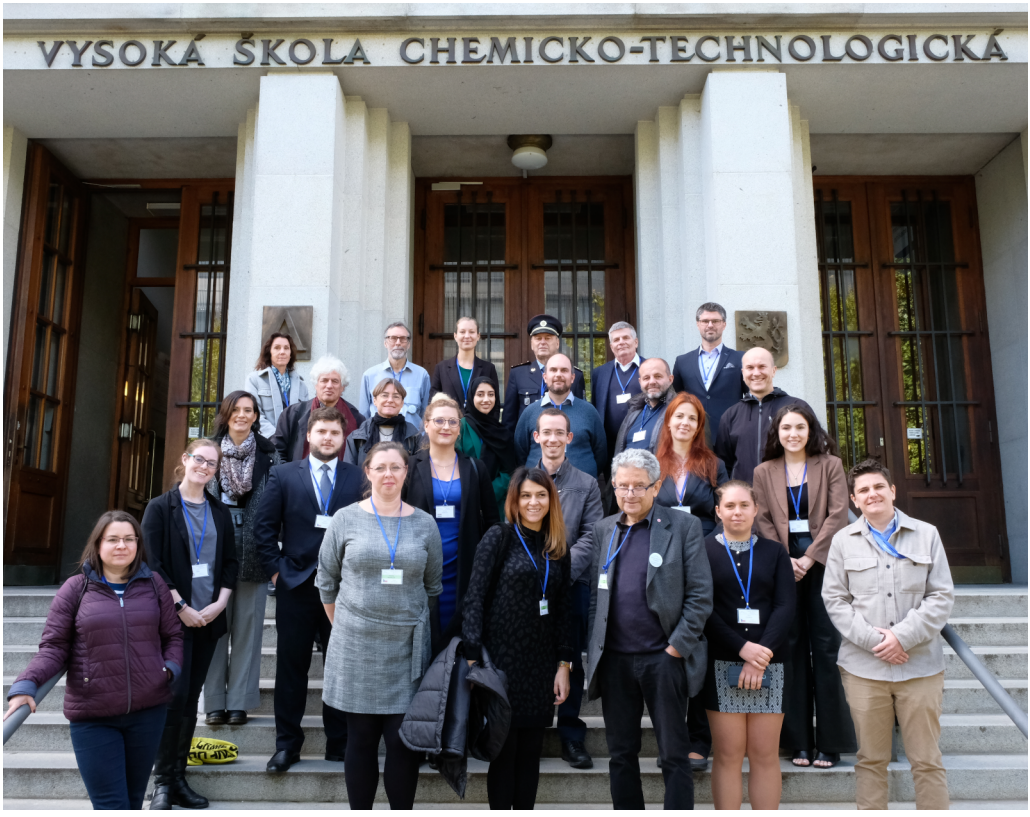
[7] M. E. Hair, A. I. Mathis, E. K. Brunelle, L. Halámková, J. Halámek, *Anal Chem*. **90**(8), 5322-5328, 2018

Adress of the workshop site:

University of Chemistry and Technology, Prague
Technická 5, 16628 Prague 6
Czech Republic


VYSOKÁ ŠKOLA CHEMICKO-TECHNOLOGICKÁ

	Thursday	Friday
09:30	Urban	Scent Collection and Preparation of the Samples
10:00	Pinc	
	coffee break	Individual Identification
10:30		
	Kaminskyi	coffee break
11:00	Landisová	
	Pojmanová	Individual Identification II
11:30	Čechová, Malá	
	Cuzuel	
12:00	Thiebaut	lunch
	Rivals	
12:30	lunch	
13:00		
13:30		Class Identification of Persons
	Jha	
14:00	Penn	
	Ferry	
14:30	Raynolds	Digitization of Scent Signatures and Their Database
	Irish	
15:00	Ratcliffe	
	Alghafri	
15:30	coffee break	coffee break
16:00	Horvát	Other Topics
	DeGreeff-Silk	
16:30	Furton	
	Banks	Creation of an International Olfactronic Community
17:00	Halámek	
17:30		

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