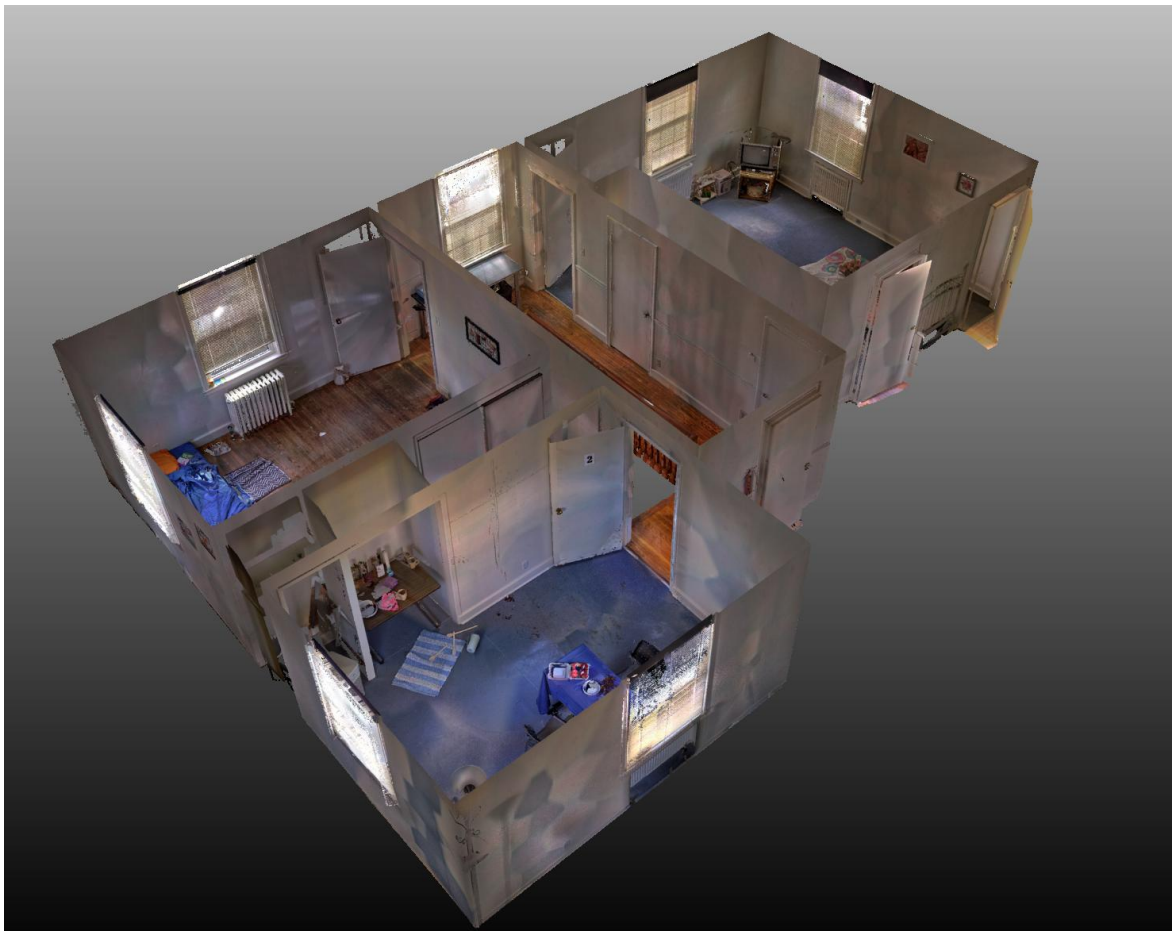
WELCOME TO THE 18th ANNUAL

FORENSIC SCIENCE RESEARCH DAY



Thursday, April 23rd, 2026
- Regent Theatre -

OntarioTech UNIVERSITY

FARO 3D scan image by: Jason Papernov

ONTARIO TECH FORENSIC SCIENCE RESEARCH DAY 2026

Program Schedule

8:30 a.m.	Registration	
9:00 a.m.	Land Acknowledgement & Opening Remarks	Kimberly Nugent, MSc *Associate Teaching Professor*
9:05 a.m.	Keynote Address	Jon Millman, PhD *Head - Research and Development, Centre of Forensic Sciences*
9:15 a.m.	Session I	Chair: Jeff Ward, BFI *Adjunct Professor*
10:55 a.m.	Session II	Chair: Jeff Ward, BFI *Adjunct Professor*
12:10 p.m.	Light lunch is served	
12:40 p.m.	Session III	Chair: Hélène LeBlanc, PhD *Associate Professor*
1:40 p.m.	Closing Remarks & Group Photo	Hélène LeBlanc, PhD *Associate Professor*

The research conducted by our fourth-year students would not have been possible without the support and mentorship of our supervisors and mentors!

THANK YOU!

Mission Statement

The Forensic Science program at Ontario Tech University strives to create an interdisciplinary learning environment dedicated to education in, research for, and contribution to the forensic community.

Specifically, the Forensic Science program at Ontario Tech University endeavours to:

- Advance the highest quality of knowledge, skills and abilities through excellence in teaching and a technologically-enhanced learning environment;
- Foster inquiry, critical thinking and scholarship in innovative research by providing access to state-of-the-art facilities and supervision by internationally recognized faculty and professional experts;
- Actively collaborate with industry to produce outstanding graduates who are consistently sought after and highly valued by professional partners and employers;
- Command next-generation leaders demonstrating integrity, ethical behaviour, and professional conduct in the field of forensic science;
- Contribute to society through community participation, leadership and outreach initiatives, with the goal of inspiring youth.

Forensic Science Program Accreditation

We are pleased to announce that our program was successful in obtaining re-Accreditation. It is the second such program in Canada granted this distinction by the American Academy of Forensic Sciences' Forensic Education Programs Accreditation Commission (FEPAC). Congrats!

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Ontario Tech Forensic Science

Schedule

9:00 **Welcome and Opening Remarks**
Kimberly Nugent, MSc

9:05 **Keynote Address**
Jon Millman, PhD

Jon Millman is the Head of Research and Development at the Centre of Forensic Sciences in Toronto, Ontario. He holds bachelor's and doctoral degrees in Biochemistry from McMaster University and completed post-doctoral training in the Department of Molecular and Medical Genetics at the University of Toronto, where his research focused on functional genomics and cancer biology.

Jon joined the CFS in 2005 as a forensic scientist in the Biology Section and later served as a Biology Manager for over seventeen years. During that time, his duties included oversight of violent crime casework and leading the Biology research and development program, publishing on topics including the transfer and persistence of bodily fluids and DNA, as well as collaborative work exploring novel technologies such as the application of microfluidic approaches to forensic analysis.

In his current role, Jon is responsible for leading and advancing research and development across all forensic disciplines at the Centre, supporting the integration of science, innovation, and evidence-based practice in forensic casework.

Session I **Mock Crime Scene Practicum & Directed Studies**
Chair: Jeff Ward, BFI

Mock Crime Scene Practicum Course

The focus of the Mock Crime Scene Practicum is to apply practical skills to process a complex crime scene. This is accomplished by simulating all the associated events a person may encounter from crime scene to court. This includes extensive documentation of the scene, collection and identification of evidence, creation of detailed logs and forensic reports, and finally testifying as an expert witness in a mock court setting. Students selecting this capstone experience are expected to individually prepare a written report and collaborate on an oral presentation.

9:15 **Raiden Amendra, Dunstan Jacob Balagtas, Merdiya Gheddai, Juliano Gintoli, Andrea Gomes, Richard Gutierrez Cisneros, Jesutunmise Ogunlusi, Siya Patel, Charmaine Puruganan, Amelia Rappoccio, Celeste Saade, Devika Satheesh Nair**

Directed Studies

A Directed Studies Project is a literature-review based research project which allows students to investigate more diverse subject matter where conducting original research may be difficult. Under faculty supervision, students conduct a comprehensive literature review of an assigned topic and produce a project-specific deliverable which may be of interest to the broader forensic science community. Examples include a conference-style presentation or a practical component for a workshop event. In addition, the students are expected to prepare a 5-minute oral presentation summarizing their project.

9:40 **Natasha McIntyre & Myrhiam Vittadello**
Wildlife Skull Identification Workshop for the Ontario Tech University Faunal Osteology Collection

9:49 **Madeline Rauch**
Development of a Crime Scene Science Workshop for Let's Talk Science

9:56 **Ayomide Amodu**
Geographic Variation in Developmental Data for *Lucilia sericata* and Implications for Forensic Time of Colonization Estimation

10:03 **Abintha Thiruvathanan**
Review of Current Roadside Test Methods for Cannabis Products in Canada

10:10 **Shamindri Shanaya Janine Perera**
An Analysis of Environmental DNA and RNA Using Biosensors and their Applications in Forensic Science

10:17 **Jinyoung Shim**
Current and Emerging Applications in Artificial Intelligence in Cartridge Case and Bullet Analysis: Advantages and Limitations

10:24 **Theron Schweizer**
Electric Vehicle Battery Safety: Implications for Vehicle Storage

10:31 **Jason Lee Papernov**
Digitizing Crime Scenes: Applications of FARO 3D Scanning in Forensic Documentation and Education

- 17 minute break -

Session II **Thesis Research Students**
Chair: Jeff Ward, BFI

Thesis Research

The focus of a thesis project is to fill the gaps in research literature. This is achieved by reviewing previous studies, designing an experiment and conducting original examinations. Ultimately, the goal is to contribute novel research to a relevant field of forensic science or broader natural science. Students work closely with either internal or external supervisors who mentor them throughout the course of their work. Students selecting this capstone experience are expected to prepare a written thesis and oral presentation.

10:55 **Meghana Gorrepati Augustin**
Development Effect of Opiates, Fentanyl, and Morphine on the Development of *Phormia regina* (Diptera: Calliphoridae)

11:07 **Stephen Andre Tan**
When time flies: Development Rates of Black Blow Fly *Phormia regina* and Green Blow Fly *Lucilia sericata* (Diptera: Calliphoridae) Across Summer and Fall Temperatures, Typical of Southern Ontario

11:19 **Heather Fittante**
Development of a Patronymic Y-STR Haplotype Database for Use in Canadian Criminal Investigations

11:31 **Karany Sivakumaran**
Optimization of DNA Recovery from Fired and Unfired Cartridge Cases

11:43 **Aiyana Roberts**
The Effect of Device Materials, Condition, and Collection Methods on DNA Recovery from Improvised Explosive Devices (IEDs)

11:55 **Maria-Anna Mavros**
Evaluation of Swabbing and Cut-Out Sampling for DNA Profile Recovery from Underwear in Alleged Digital Penetration Cases

12:07 **Light lunch served**

Session III **Thesis Research Students**
Chair: Hélène LeBlanc, PhD

12:40 **John Sunseth**
Brønsted Acid-Catalyzed Direct N-alkylation of 1H-Pyrazoles with Alcohols

12:52 **Hana Haytaoglu**
Quantifying Colour Perception Distortion: Effects of Light Source and Time Delay on Eyewitness Accuracy for Non-Transparent Objects

1:04 **Gina Mondesir**
A Transfer and Persistence Study on Glass in Relation to Retention Time on Footwear

1:16 **Dayna Ripley**
A Study of Sciluminate™ Powder for Fingerprint Development on Vehicle Substrates

1:28 **Adrianna Kapanaiko**
Comparative Evaluation of Alternate Black Powder, Liqui-Drox, TapeGlo™, and Wet Powder™ for Latent Fingerprint Development on Adhesive Substrates

1:40 Closing Remarks & Group Photo!

CONGRATULATIONS TO THE GRADUATING CLASS OF 2026! WE ARE ALL VERY PROUD OF YOU!

Thank you to everyone in attendance today.

Your support of our capstone projects is greatly appreciated!

Mock Crime Scene Practicum

Raiden Amendra, Dunstan Jacob Balagtas, Merdiya Gheddai, Juliano Gintoli, Andrea Gomes, Richard Gutierrez Cisneros, Jesutunmise Ogunlusi, Siya Patel, Charmaine Puruganan, Amelia Rappoccio, Celeste Saade, Devika Satheesh Nair, Jenna Comstock, PhD[1]; Kimberly Nugent, MSc[1]; Jeff Ward, BFI[1]

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The Mock Crime Scene Practicum was a 12-week course that provided students the opportunity to apply their acquired crime scene and laboratory knowledge to a practical scenario, adapted from a real-life scenario. Students participated in all aspects of a simulated major crime scene, working in three teams of four, and reporting to a Case Supervisor throughout the entirety of the investigation.

The scene examination took place at Ontario Tech University's Crime Scene House, with further analysis being conducted at the undergraduate teaching laboratory. Students maintained a paperless documentation record using OneNote software that allowed real- time data entry and collaboration among team members to record the scene, track evidence, and maintain information logs. In addition to traditional photography for scene documentation, students used a FARO scanner to capture 3D spatial data of their scene. Identifiable evidence varied and included: footwear impressions, fingerprints, toolmark impressions, blood, and bloodstain patterns.

Laboratory analyses included: processing 3D scans and creating a digital 3D model using SCENE software, bloodstain pattern analysis, examination of blood using forensic light sources, toolmark comparisons, as well as fingerprint and footwear examination and comparisons. The investigation culminated with a case report summarizing the actions, findings, and conclusions, followed by a case review with the Case Supervisor. Throughout the duration of the capstone course, students honed the necessary skills required to be effective at a crime scene, including but not limited to judgment, critical thinking, deductive reasoning, and teamwork skills.

Wildlife Skull Identification Workshop for the Ontario Tech University Faunal Osteology Collection

Natasha McIntyre*; Myrhiam Vittadello*; Nelson Lafrenière, PhD[1]; Kimberly Nugent, MSc[1]

*Co- First Authors; [1]Faculty of Science, Ontario Tech University

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This project aimed to develop a structured wildlife skull identification workshop for upper-year high school students using the Ontario Tech University wildlife osteology collection. This involved the creation of a dichotomous key, a skull identification protocol, and a teacher's guide. The dichotomous key was developed by studying distinguishing morphological features, including the greatest skull length, dentition, rostrum length, orbit position, orbit posterior, orbit diameter, supraoccipital crest prominence, infraorbital foramen, and shape of the caudal margin of the palatine bone. The identification protocol was developed using cranial measurements of the key morphological features, across eleven skull specimens representing a range of vertebrate taxa, including mammals and reptiles. Measurements were repeated multiple times to establish ranges, and anatomical features such as orbit morphology and dentition were systematically assessed. Data was integrated into a structured, station-based identification protocol (developed by Myrhiam Vitadello) supported by a dichotomous key (developed by Natasha McIntyre), and a teacher's guide (developed by both students). In summary, this project demonstrated that a structured identification protocol improved consistency and supported the application of comparative osteology in an educational context. While limitations related to sample size and measurement variability were identified, the protocol provided an accessible and reproducible approach for teaching wildlife skull identification and supported the use of morphological analysis in both educational and forensic contexts.

Development of a Crime Scene Workshop for Let's Talk Science

Madeline Rauch; Nelson Lafrenière, PhD[1]; Stephanie Mavilla, MSc[1]

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Let's Talk Science is an award-winning, national, charitable organization that provides free STEM-based workshops for elementary-level students. The organization partners with universities to deliver workshops in their surrounding communities. Let's Talk Science has partnered with Ontario Tech University for over 15 years for outreach to local youth across Durham Region and the surrounding area. Workshop topics explore many disciplines such as physics, ecology and astronomy, a popular workshop in Durham Region is the 'Crime Lab'. This workshop introduces students to forensic science and provides a foundational understanding of theory and techniques. The purpose of this project was to review the curriculum of the 'Crime Lab' workshop and revise content with a focus on clarity, relevancy, and student engagement. The revision of this project included updating four parts of the workshop to improve forensic relevance and introducing a new section for a further learning opportunity. Key concepts and techniques included fingerprinting, toolmark impression examination, chromatography, chemical testing and footwear impression evidence.

Geographic Variation in Developmental Data for *Lucilia sericata* and Implications for Forensic Time of Colonization Estimation

Ayomide Amodu; Nelson Lafrenière, PhD[1]

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Forensic entomology relies on temperature-dependent insect development to estimate the minimum postmortem interval (minPMI). Developmental datasets are often applied across geographic regions; however, the extent to which regional variation influences development remains unclear. This study aimed to evaluate whether developmental rates of *Lucilia sericata* differ among geographic populations under comparable temperature conditions. A structured literature review was conducted using peer-reviewed developmental studies. Data was extracted and standardized, with comparisons restricted to an overlapping temperature of 20°C. Developmental durations were compared across European and North American populations. At 20°C, U.S. populations exhibited longer development times than European datasets, with differences ranging from approximately 21 to 47 hours. Intra-regional variation of 16.6 hours was also observed among U.S. populations. These findings demonstrate measurable geographic variability in developmental timing. The results suggest that developmental datasets are not universally transferable and that the use of non-local data may introduce error into forensic estimations. Incorporating geographic variation into developmental models may improve the accuracy of time of colonization estimates in forensic casework.

Review of Current Roadside Test Methods for Cannabis Products in Canada

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Since the legalization of cannabis in Canada, concerns have been raised regarding impaired driving under the influence of cannabis. To implement stricter guidelines, the Government of Canada inaugurated Bill C-46 to help reduce impaired driving, along with the current roadside test methods. The current roadside test methods are Oral Fluid (OF) collection and screening methods, as well as confirmatory testing techniques to check for impairment and detect the presence of Δ9-THC and its metabolites. This study aimed to review the current roadside test methods conducted in Canada along with the advantages and disadvantages associated with them.

FORENSIC SCIENCE

An Analysis of Environmental DNA and RNA Using Biosensors and their Applications in Forensic Science

Shamindri Shanaya Janine Perera; Nelson Lafrenière, PhD[1]

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Environmental DNA and RNA (eDNA and eRNA, respectively) are trace amounts of genetic material shed by individuals or other organisms into their surroundings that can be recovered from environmental substrates, such as water, dust, air, and soil. eDNA and eRNA are currently used in biodiversity management, to detect the presence of invasive species, and can detect pathogens in wastewater, which can serve as an early warning sign of a pandemic. They can also detect microplastics and heavy metals in aquatic environments to monitor pollution. Their applications in forensic science are being explored to link individuals to a location and to identify contamination levels of DNA in forensic labs. eDNA and eRNA are analyzed using biosensors and some of them are reverse transcription-quantitative polymerase chain reaction (RT-qPCR) and clustered regularly interspaced short palindromic repeats (CRISPR-Cas) designed to target DNA and RNA. Unfortunately, eDNA and eRNA are subject to environmental degradation, and the rate of degradation is influenced by different factors, such as temperature and pH. Additional research is required to validate collection techniques and to standardize their use in forensic contexts.

Current and Emerging Applications in Artificial Intelligence in Cartridge Case and Bullet Analysis: Advantages and Limitations

Jinyoung Shim; Nelson Lafrenière, PhD[1]

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Artificial intelligence (AI) is being used with increasing frequency across many areas of modern society. While it has long been associated with fields such as art and engineering, its influence is now extending into the natural sciences, including chemistry, biology, and physics. Within this broader shift, forensic science has also begun to incorporate AI as a tool for both research and practical casework. Given that forensic investigations often require the examination of large volumes of evidence, experimental data, and case materials by a limited number of trained specialists, ongoing personnel shortages have highlighted the need for approaches that can improve both efficiency and reliability. In firearm cases, bullets and cartridge cases are among the most critical forms of evidence used for firearm identification. However, despite the increasing number of such cases, the availability of trained firearm examiners remains relatively limited. This imbalance can contribute to delays in analysis and increased pressure on practitioners. As a result, AI-based methods are being explored to assist with the processing and interpretation of large datasets in a more consistent and timely manner. This study examines the potential applications and limitations of AI in forensic science, with a particular focus on firearm identification. It considers how AI-based approaches compare to conventional methods and evaluates their potential to improve efficiency and analytical objectivity. In doing so, the study aims to contribute to ongoing discussions regarding the future role of AI in forensic practice.

Electric Vehicle Battery Safety: Implications for Vehicle Storage

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There are many new fire safety challenges associated with the increasing adoption of electric vehicles (EVs). This is especially a concern in situations where damaged or unstable vehicles are stored for extended periods, such as in forensic or vehicle storage environments. Lithium-ion battery systems behave differently from traditional fuels, as they can generate large amounts of heat quickly upon ignition, burn for prolonged periods of time, and remain unstable after suppression, creating a risk of delayed re-ignition due to thermal runaway. This study reviews current literature to examine the hazards associated with EV battery fires, with a focus on storage conditions and post-incident management. The primary factors influencing fire risk in these environments include radiant heat transfer, storage configuration, and battery failure, with tight spacing between vehicles increasing the likelihood of ignition and fire spread. Practical risk reduction methods are also explored, including increased spacing, monitoring strategies, and the use of intake assessment indicators such as temperature increases, physical damage, and gas emissions. Current studies give much needed insight into EV fires, however there are gaps in uniform safety standards and in incident data available for use in real-world applications. Overall, this study demonstrates the need to combine scientific knowledge with practical approaches to enhance fire safety in EV storage environments.

FORENSIC SCIENCE

Digitizing Crime Scenes: Applications of FARO 3D Scanning in Forensic Documentation and Education

Jason Lee Papernov; Nelson Lafrenière, PhD[1]; Jenna Comstock, PhD[1]; Kimberly Nugent, MSc[1]

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Traditional crime scene documentation is a time-consuming process, often providing limited spatial context for future long-term investigative review. FARO 3D scanning is popular in both crime scene documentation and subsequent courtroom presentations. In this paper, the function and application of FARO technology to large- and small-scale crime scenes and forensic documentation are reviewed. FARO's Terrestrial Laser Scanner (TLS) models, the FARO Focus, and their handheld Structured Light Scanner (SLS) models, the FARO Freestyle series, have been validated for a wide range of evidence types. Such 3D scanners create millimetre-accurate records of crime scenes that can be navigated using software such as FARO SCENE and FARO Zone 3D. These contain forensic tools for bloodstain pattern analysis, bullet trajectory analysis, crash reconstruction, forensic anthropology and archaeology, and several types of digital forensics related to handheld and security cameras. However, an overall lack of validation of specific FARO software tools and the application of FARO scanners to specific crime scene evidence types was identified. A culminating task to this project included the digitization of a mock scene at the Ontario Tech Crime Scene House, using a FARO Focus^{M} 70 scanner and FARO SCENE software to create a high-quality point cloud and fly-through videos.

Development Effect of Opiates, Fentanyl, and Morphine on the Development of *Phormia regina* (Diptera: Calliphoridae)

Meghana Gorrepati Augustin; Hélène LeBlanc, PhD[1]

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Forensic entomology is a widely accepted method for estimating the minimum post-mortem interval (minPMI) in decomposed remains based on the developmental progression of necrophagous blow flies. Although this method is well established, numerous factors can influence insect development and, consequently, the accuracy of minPMI estimation. Failure to account for these factors may compromise forensic investigations and result in erroneous conclusions. One emerging factor of concern is the increasing prevalence of opioid use and opioid-related deaths across Canada. In many such cases, remains are discovered in advanced stages of decomposition, leaving insect evidence as the primary means of minPMI estimation. As blow fly larvae feed on decomposing tissues, they may bioaccumulate drugs present in the body, potentially altering their development. Despite its forensic relevance, knowledge regarding the entomotoxicological effects of opioids on blow fly development remains limited. This study examines the impact of morphine and fentanyl exposure on blow fly larval development. Rainbow trout (*Oncorhynchus mykiss*) were dosed with morphine or fentanyl at concentrations scaled to body mass to reflect physiologically relevant exposure. Following a 30-minute metabolism period, the trout were euthanized and subsequently colonized with blow fly larvae. Larvae were reared on treated tissues under controlled conditions and sampled throughout development to assess changes in developmental rate, larval length, and mass. Preliminary results indicate that morphine exposure alters developmental progression relative to the control. In contrast, fentanyl exposure appears to primarily affect larval length, with differences observed between treated groups and controls. This study contributes to the relatively limited body of research in entomotoxicology, particularly for opioids. It helps move the field toward more accurate, case-relevant minPMI estimations and highlights the need to incorporate toxicological context into forensic entomology analyses.

When Time Flies: Development Rates of Black Blow Fly *Phormia regina* and Green Blow Fly *Lucilia sericata* (Diptera: Calliphoridae) across summer and fall temperatures typical of southern Ontario

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Forensic entomology has numerous applications, most notably the estimation of the minimum post-mortem interval (minPMI), often referred to as time of colonization. Accurate minPMI estimation relies on reliable, species-specific insect development data, which has been shown to vary regionally. Consequently, forensic entomologists require development data that closely reflects the geographic location where remains are discovered. However, much of the published development data for common blow fly species is derived from laboratory colonies originating in the southern United States or Asia, limiting its applicability to Canadian casework. The objective of this study was to generate regionally relevant development data for *Phormia regina* and *Lucilia sericata* (Meigen) using locally sourced populations and temperature regimes representative of summer and fall conditions in southern Ontario. Controlled laboratory development experiments were conducted at constant temperatures of 17 °C, 20 °C, 23 °C, and 25 °C. Immature specimens were sampled at regular intervals throughout development and prepared for analysis. Developmental stage was determined for each specimen, with larvae and pupae weighed and larval length measured. Prepupal stages were visually observed, and egg hatch and adult emergence were recorded across sampling intervals. Developmental trajectories were analyzed using quantile regression to characterize stage-specific growth patterns across temperatures. For *L. sericata*, development at 23 °C and 25 °C differed from published datasets, while *P. regina* exhibited accelerated development at these same temperatures relative to the literature. These findings highlight regional variation in blow fly development and provide locally relevant data to improve the accuracy of minPMI estimations in southern Ontario.

Development of a Patronymic Y-STR Haplotype Database for Use in Canadian Criminal Investigations

Heather Fittante; Cecilia Hageman, PhD[1,2], LLB, LLM; Valerie Blackmore, MSc[2]

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The detection and identification of genetic relatives serves many purposes, from understanding family health history, documenting family history and genealogy, to the use of Investigative Genetic Genealogy (IGG) in a forensic context. The use of Y Chromosome Short Tandem Repeat (Y-STR) DNA profiles is not equivalent with IGG, though both methods are used to detect genetic relatives, the former using autosomal genetic loci, and the latter restricted to locations on the Y chromosome.

The three major public forensic laboratories in Canada generate both autosomal STR (A-STR) and Y-STR DNA profiles from crime scene samples. There is currently no retention or comparison of Y-STR profiles in the National DNA Data Bank (NDDB) of Canada. In situations where the NDDB is unable to make a match to an autosomal profile, casework can be stalled. Despite its potential to generate investigative leads, the data generated by the Y-STR profile remain unused. A Y-STR database for investigative use is not currently occurring in Canada.

In this study, publicly available Y-STR profiles were identified on FamilyTreeDNA (FTDNA) Group Project pages. Initial visits indicated up to 12,308 group projects, necessitating a methodical workflow to investigate projects with a Canadian component. as well as adjacent United States border states and Bermuda. A protocol was developed to acquire and transfer webpage data into Excel workbooks. The Y-STR loci reported by FTDNA was compared to the loci contained within Y-STR typing kits currently used by the Canadian forensic laboratories. The data were reduced to extricate 78 extraneous loci not contained within the PowerPlex® Y23 and Yfiler Plus® Y-STR typing kits. All publicly available data that satisfied the scope of the investigation were harvested to produce a database known as ‘the MantYcore’. The MantYcore currently contains up to 12,674 Y-STR profiles with a connection to Canada, 17,660 Y-STR profiles with a connection to the adjacent United States border states, and zero profiles with a connection to Bermuda. A maximum of 30,334 Y-STR profiles were harvested.

Proof-of-concept testing was used to test a beta version of the test-database. Deficiencies identified as part of the beta testing are in the process of being remediated, which will enable more robust profile comparisons and prioritization of higher quality investigative leads. Initial findings suggest that the provided commercial interface is a suitable platform for use in conjunction with the MantYcore, and that this investigative tool will be available for use in unresolved case work within Canada.

Optimization of DNA Recovery from Fired and Unfired Cartridge Cases

Karany Sivakumaran; Stacey Sainte-Marie, MSc[1]; Kimberly Nugent, MSc[1]; Amanda Lowe, MSc[2]

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Recovering DNA from fired and unfired cartridge cases may provide valuable biological evidence in firearm-related investigations. However, challenges associated with the firing process can make it difficult to obtain high DNA yields from degraded samples, including fired cartridge cases. This study investigated the effectiveness of the soaking method combined with a bovine serum albumin (BSA) additive to reduce metalion inhibition, in order to determine whether there is a significant difference in DNA yield between fired and unfired cartridge cases and whether sufficient DNA can be recovered for amplification. DNA quantification revealed an average concentration of 0.7403 pg/µL from unfired cartridge cases and 0.8515 pg/µL from fired cartridge cases, with fired samples demonstrating a higher DNA yield, which is atypical compared to previous studies. The results indicated no statistically significant difference in DNA concentrations between unfired and fired samples ($p=0.216$). Additionally, an average of 0.3744 pg/µL of male DNA was detected in unfired cartridge cases, while no male DNA was detected in fired samples. Although DNA was successfully recovered, the quantities obtained were insufficient for amplification (0.5–1.0 ng). These findings highlight the need for further research to optimize DNA recovery methods, particularly the use of the soaking method with BSA, and to better understand the impact of the firing process and collection methods on DNA recovery from fired and unfired cartridge cases.

The Effect of Device Materials, Condition, and Collection Methods on DNA Recovery from Improvised Explosive Devices (IEDs)

Aiyana Roberts; Kimberly Nugent, MSc[1]; Stacey Sainte-Marie, MSc[1]; Joanne Cox, BSc[2]; Alexandra Salvati, BSc[2]; Sonja Stadler, PhD[2], Jonathan Millman, PhD[2]

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Improvised explosive devices (IEDs) is of relevance to forensic science when assessing terrorism-related threats. These devices are commonly used because of their easily accessible components and simple construction. The Centre of Forensic Sciences (CFS) sampled IED components from over 50 cases to assess the instances in which DNA evidence may be reliably collected and produce optimal results for uploading to the Combined DNA Index System (CODIS) database. Of the 50 samples that were collected and amplified, 40 samples were suitable for interpretation and 28 met the criteria for CODIS upload. Statistical analyses were conducted to observe whether the IED components, device condition, or sample collector affected the ability to generate an interpretable profile. A total of 15 comparisons were performed, where 13 had no significant differences between the variables indicating that the ability to generate an interpretable profile is not affected by IED components, device condition, or sample collector. In summary, it is possible to collect an interpretable profile from an IED using a traditional sample collection method, with these findings assisting forensic labs in their DNA analysis of IED cases.

FORENSIC SCIENCE

Evaluation of Swabbing and Cut-Out Sampling for DNA Profile Recovery from Underwear in Alleged Digital Penetration Cases

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The recovery of probative DNA from underwear in alleged digital penetration cases is often limited by low levels of male DNA and interference from background female DNA. This study evaluated whether direct swabbing yields male DNA profiles that are as or more informative than the standard approach of body fluid screening followed by cut-out sampling. Eleven sexual assault cases from the Centre of Forensic Sciences were analyzed, comparing DNA recovery, total-to-male DNA ratios, and profile development between swab (n = 18) and cut-out (n = 9) samples. All epithelial fraction samples exceeded the 240 pg threshold for autosomal STR analysis, while approximately half met the 100 pg threshold for Y-STR. Most sperm fraction samples fell below both thresholds. Cut-outs generally produced higher total DNA quantities but showed greater variability, whereas swabs produced more consistent results and frequently higher male DNA quantities. Swabs generated male DNA profiles in 64% of cases compared to 44% for cut-outs, and in cases where both methods were used (n = 9), swabs were successful in 6 cases versus 4 for cut-outs. Overall, 14 Y-STR and 8 autosomal STR male profiles were developed, with all autosomal and 64% of Y-STR profiles suitable for comparison. Swabs produced the majority of autosomal profiles. These findings demonstrate that body fluid screening is not required to obtain informative DNA profiles and that swabbing can yield equivalent or improved results compared to cut-out sampling. The more consistent total-to-male DNA ratios observed in swabs suggest an advantage in recovering interpretable profiles, particularly in cases where male DNA is limited. This study supports the consideration of swabbing as a targeted and potentially more effective standard approach for underwear examination in digital penetration cases, with implications for improving both evidentiary value and laboratory efficiency.

FORENSIC SCIENCE

Brønsted Acid-Catalyzed Direct N-alkylation of 1H-Pyrazoles with Alcohols

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New methodologies for the alkylation of Nitrogen containing heterocycles are extremely valuable to the pharmaceutical industry, as these heterocycles, such as 1H-pyrazole, are capable of acting as hydrogen bond donors and acceptors, controlling their physical properties such as enzyme affinity and aqueous solubility [1]. Current synthetic approaches to the alkylation of 1H-pyrazole exhibit various limitations, highlighting the need for inexpensive and simple methodologies to achieve this transformation. As opposed to the currently available synthetic motifs for the alkylation of 1H-pyrazole, Brønsted acid-catalyzed reactions offer an inexpensive and safe alternative to modern synthetic motifs. In this research, a Brønsted acid-catalyzed methodology for the N-alkylation of 1H-pyrazole has been developed. The desired products were obtained in moderate to good yields using 35 mol % tetrafluoroboric acid (HBF_4) (aq.) as a catalyst. The developed reaction system catalyzed reactions for a large scope of benzhydryls and 1H-pyrazole derivatives, exhibiting good tolerance of electron rich and sterically hindered substrates, and moderate tolerance of electron deficient and ester functionalized substrates. This convergent approach to the alkylation of 1H-pyrazole derivatives offers an inexpensive and practical alternative to currently used methodologies and provided thermally stable reaction products. Future directions of this research should focus on an investigation of the developed systems tolerance of functional groups such as carboxylic acid, amines, and alcohols, and further investigate the effectiveness of other commercially available Brønsted acid-catalysts to further optimize cost.

FORENSIC SCIENCE

Quantifying Colour Perception Distortion: Effects of Light Source and Time Delay on Eyewitness Accuracy for Non-Transparent Objects

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Colour perception and memory accuracy are important factors in forensic investigations, where eyewitness colour descriptions are often used as evidence. This study examined how light source colour rendering index (CRI), base material, surface finish, gender, and time delay intervals influence colour perception and recall accuracy for certain colours. Two controlled experiments were conducted to evaluate these effects. The first experiment assessed colour memory across four time intervals (Immediate, 30 minutes, 1 day, 1 week) and examined the relationship between confidence and accuracy. Results showed that stimulus colour influenced memory accuracy more strongly than time delay, with red, green, and blue recalled more accurately than other colours. A significant ($P<0.05$) decline in memory accuracy occurred only between the immediate and 30-minute intervals. Confidence shows a statistically significant ($P<0.001$) but weak-to-moderate relationship with accuracy; however, high-confidence responses generally exceeded 80% accuracy overall. The second experiment measured perceptual accuracy under five lighting conditions with varying CRI values, where lower CRI lighting produced significant colour distortion ($P<0.005$), particularly under high-pressure sodium lighting (CRI 22). Surface finish demonstrated minimal influence on perceptual accuracy, while base material differences were significant under low-CRI conditions, and gender-related differences were observed for several colour components, specifically in green samples. Future directions include isolating the variable of CRI in light systems, observing the effects of age on colour perception, and creating a code to predict true colour from a perception based on the variables of an eyewitness and the environment.

A Transfer and Persistence Study on Glass in Relation to Retention Time on Footwear

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This study looks into the transfer and persistence of glass pieces on footwear, specifically the impact of fragment size, surface type, and time. Glass fragments were transferred to the sole of a running shoe after being divided into large and medium size groups. Two surface types, grass and asphalt, were used to quantify transfer and persistence during a 30-minute period at predetermined intervals (0, 2, 5, 10, 15, and 30 minutes). Photographic analysis was used to record fragment counts, which were then statistically assessed using Shapiro-Wilk, ANOVA,Kruskal-Wallis, and post hoc tests as necessary. The findings showed that compared to large fragments, medium-sized fragments transferred in much larger numbers. The first two minutes saw a significant drop in fragment counts under all circumstances, which was followed by a steadier reduction over time. The kind of surface had a significant effect on persistence; asphalt allowed limited retention up to 30 minutes, but grass promoted nearly total fragment loss after 10 minutes. Although changes across later intervals were typically not significant, statistical analysis verified significant differences between the initial transfer and subsequent time intervals. Overall, the results show that glass evidence on shoes is very transient and affected by physical and environmental conditions. While surface features have a significant impact on retention, medium-sized pieces exhibit higher transfer efficiency and persistence. These findings emphasize how crucial it is to take substrate type, fragment size, and time since transfer into account when analyzing glass evidence in forensic settings.

FORENSIC SCIENCE

A Study of Sciluminate™ Powder for Fingerprint Development on Vehicle Substrates

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Latent fingerprints recovered from vehicle substrates are a crucial form of forensic evidence, supporting the identification of individuals and their association with crime scenes. These invisible impressions are commonly developed using methods such as cyanoacrylate fuming followed by Rhodamine 6G fluorescent staining (CA/R6G), a primary technique used to process latent fingerprints on non-porous substrates. However, this development method has several limitations, including the requirement for specific heating and humidity conditions achieved within a controlled chamber, risks of overdevelopment, permanent chemical alteration of the treated substrate, and the production of toxic fumes. Sciluminate™ powder, a rare-earth metal-based fluorescent nanopowder, has been proposed as a rapid, alternative to traditional methods, capable of producing high-contrast fluorescence and fine friction ridge detail, while allowing for non-destructive removal without permanent alteration to evidentiary substrates. However, its performance has not been independently evaluated in the peer-reviewed scientific literature. Therefore, this study aimed to assess whether Sciluminate™ could develop high-quality friction ridge detail and serve as an alternative to the CA/R6G method by evaluating its performance across common non-porous vehicle substrates. A total of 222 latent fingerprints from three donors were deposited onto a vehicle fender (painted metal), rear-view mirrors (reflective glass front and textured plastic backing), media screens (glass), and seatbelt buckles (textured plastic). Following a 24-hour aging period under controlled laboratory conditions, fingerprints were developed using either Sciluminate™ powder (n = 111) or CA/R6G (n = 111). Developed impressions were photographed, classified using the Home Office (HO) grading scheme (Classes 0–4), and statistically analyzed using the Wilcoxon signed-rank test. Results indicated that Sciluminate™ yielded significantly higher fingerprint classification scores ($p = 0.043$) compared to CA/R6G, with high-quality development (Classes 3–4) observed in a greater proportion of evaluated fingerprints (68.46% vs. 61.26%). In addition, Sciluminate™ demonstrated a statistically significant improvement on smooth, non-porous surfaces. Overall, these findings indicate that Sciluminate™ may be an effective alternative to the CA/R6G method, offering practical advantages for latent fingerprint development on vehicle substrates, including rapid, simplified processing and easy removal to facilitate the timely and non-destructive return of vehicles to registered owners.

FORENSIC SCIENCE

Comparative Evaluation of Alternate Black Powder, Liqui-Drox, TapeGlo™, and Wet Powder™ for Latent Fingerprint Development on Adhesive Substrates

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The development of latent fingerprints on adhesive substrates remains a persistent challenge in forensic science due to the complex chemical composition of pressure-sensitive adhesives (PSAs) and the dynamic nature of fingerprint residues. Currently, operational approaches have relied in part on TapeGlo™; however, its discontinuation by the manufacturer has created a need for validated alternative techniques. This study evaluated the effectiveness of four development methods: Alternate Black Powder (ABP), Wet Powder™, Liqui-Drox, and TapeGlo™ for the visualization of latent fingerprints on three adhesive substrates (duct, electrical, and packing tape) across three aging periods (24 hours, 7 days, and 60 days). A total of 540 fingerprints were deposited by three female donors, aged 21 to 40 years, and developed according to method-specific procedures. Friction ridge development quality was assessed using a five-point grading scheme, and statistical analyses were performed using non-parametric tests appropriate for ordinal data. ABP and Wet Powder™ demonstrated superior performance (medians = 3–4), maintaining consistency across substrates and aging periods. In contrast, Liqui-Drox exhibited consistently poor performance (medians = 0–1) and was more affected by substrate type and aging period than other methods. TapeGlo™ demonstrated moderate but variable performance (medians = 1–3), with results also influenced by these factors. Substrate-related effects were observed, particularly for packing tape, where powder-based methods showed increased non-selective background staining. Overall, these findings provide operational guidance for the selection of fingerprint development techniques on adhesive substrates. ABP and Wet Powder™ were identified as the most effective and reliable methods under the conditions tested, supporting their use as practical alternatives to TapeGlo™.