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How Chemistry, Microbiology Could Help Catch a Killer

By Jamie Wells, M.D. — January 18, 2018

Credit: Pixabay [1]

For a doctor, putting puzzle pieces together is essential to becoming a master diagnostician. Being a detective is a vital skill employed daily in medical practice. So, despite the fact forensics routinely involves the deceased and primary care the living, the two disciplines amazingly run in parallel, sharing much common ground.

As a result, a new report on expanding the use of science to estimate time of death better in suspected homicides caught my attention.

After all, I did consider being a medical examiner for a whole week many years ago -- until I recognized that working all day usually without windows in basements, never delivering happy news and being surrounded by the macabre day in and day out might not best gel with my optimistic nature and spirited disposition. Instead, I binge watch *Law & Order* and its various permutations, documentaries and read fascinating medical mysteries to get my fix and hone my problem-solving abilities.

This brings me to work just published in *Scientific Reports* [2] which details the challenges of determining time of death after a long post-mortem interval (PMI, or time after death) in criminal investigations of suspected homicide. Estimating the PMI is a main focus within forensic science dating back to 1894 when stages of body decay and decomposition were first defined.

Estimating minimum PMI (PMI_{min}) depends on medical assessment of the body's physical changes and entomological evidence. This method of evaluation can be pretty reliable within hours, weeks, even months of death, but with the greater passage of time the PMI_{min} accuracy weakens. Thankfully, it is infrequent that such older decomposed bodies are found that warrant

more involved investigations, but it does happen often enough for the authors of this study to recommend the utility of combining several independent lines of evidence to pinpoint more ideally PMI, and thus time of death.

The deterioration [3] of a corpse follows well-established stages: fresh, bloated, active decay, advanced decay, dry and remains.This is further influenced by weather conditions (e.g. temperature) and predators, for example. The *necrobiome* is understood as the microbial life after death or the dynamic ecosystem that evolves after death (see here [4]). As one's body shuts down and its internal environment allows for bacterial growth previously incompatible with life, skin break down affords entry to bugs and foreign exposures while body fluids seep out and react with the environment (e.g. soil, micro-organisms).

Analyzing a crime scene includes but is not limited to tests of the body, the soil chemistry beneath the victim and the critters to tell the ultimate tale.

In this report, the researchers presented a case of human remains discovered in a Swiss forest. Through a multidisciplinary approach, they managed to approximate the PMI of the deceased, identify him by age, gender and name and create a timeline of his movements. Through a combined analysis of the human remains alone and the soil samples beneath it, they got many answers from scrutinizing the following five components (some examples listed):

- Bone and Hair
  - young, adult human male
  - died 1-2 years prior to discovery
  - bones showed he was burned *in-situ*
  - as a result of these conclusions, he was identified - he was last seen 22 months prior
- Mites
  - helped reveal part of decomposition took place on site and the body was there at least 8-9 months with greater likelihood > 1 year
  - revealed he was moved from the original spot elsewhere to the forest soil when already in late stage of decay
  - life cycle of one type determined body burned on the soil and just months before discovery
- Nematodes
  - helped reveal part of decomposition took place on site and the body was there at least 8-9 months with greater likelihood > 1 year
- Micro-eukaryotes (like fungi)
  - helped reveal part of decomposition took place on site and the body was there at least 8-9 months with greater likelihood > 1 year
- Soil Chemical/Numerical Analyses
  - Multiple Factor Analysis (MFA), hierarchical clustering, Indicator Value

Ultimately, knowing the degenerating acceleration tendencies of a body's exposure to hot weather and the subsequent increased scavenger access it causes, they were able to conclude from all the information collected that he died in the fall or winter, started to deteriorate in a confined space (e.g. farm) then was likely moved to the final location in early spring of the next year where he was

partially exposed to fire.

Due to confidentiality issues, further descriptions were excluded. Overall, the team managed to meet their goal:

> *"The main aim of this work was to provide a strong incentive for case work as well as experimental studies to further develop a comprehensive toolbox for forensic or crime scene investigations."*

They cracked the case, so to speak.

Source:

Comparative analysis of bones, mites, soil chemistry, nematodes and soil micro-eukaryotes from a suspected homicide to estimate the post-mortem interval. [2]

Ildikó Szelecz [5], **Sandra Lösch** [6], **Christophe V. W. Seppey** [7], **Enrique Lara** [8], **David Singer** [9], **Franziska Sorge** [10], **Joelle Tschui** [11], **M. Alejandra Perotti** [12] & **Edward A. D. Mitchell** [13]. *Scientific Reports* 8, Article number: 25 (2018). doi:10.1038/s41598-017-18179-z

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