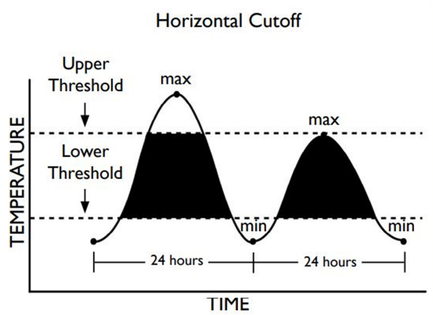
Life After Death: Using Bacterial Diversity to Determine Postmortem Interval

Elise Clancy & Jutta Heller* (TBIOMD 492)

Life After Death | References

Background

- Postmortem interval (PMI) is key to solving homicide and missing persons cases
- **No universally accepted method** for PMI determination
- **Current methods are expensive and inaccurate:** tooth enamel wear, thanatochemistry of putrefactive fluids/ organic biomarkers, DNA recovery, etc.
- Decay is driven by succession of bacteria



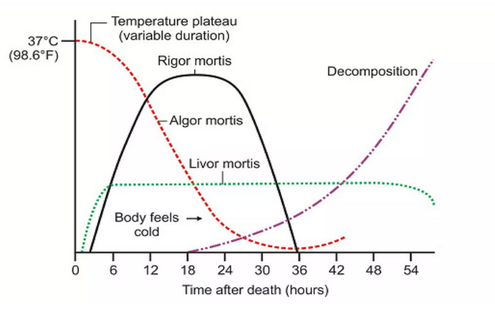


Figure 1. (Left) Graph exemplifying the degree–day system (Pixelrz.com)

Figure 2. (Right) Graph depicting the initial processes of decay. (Atul Abhishek)

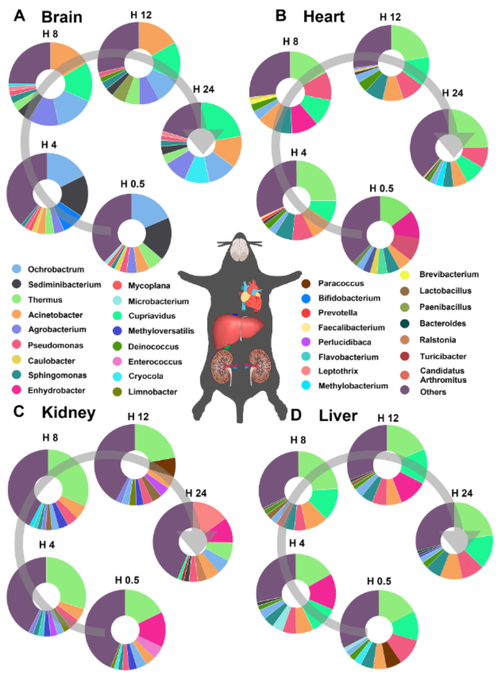


Figure 3. Bacterial α– diversity during the first 24 hours of decay in four sterile body sites (A– brain, B– heart, C- liver, D- kidney) (Liu et al. 2023).

Discussion

- Degree–day system must be used in tandem
- All PMI determination methods rely on bacterial diversity
- ***Clostridium*** increase throughout wet decay
- ***Bacteroides*** negatively correlated with PMI
- ***Proteobacteria*** positively correlated with PMI
- **Cost–effective, accessible, accurate, timely method for PMI determination**

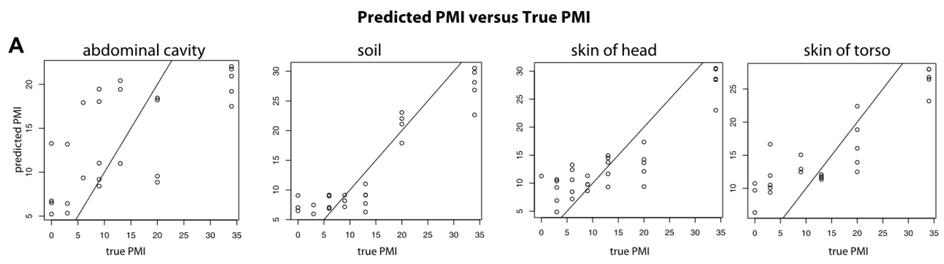


Figure 5. Results of PMI determination using bacterial diversity vs. true PMI in several body sites using invasive testing methods (Metcalf et al. 2013).

Autolysis

- Cell death begins 4 minutes postmortem
- Induced by lack of ATP and oxygen
- Frees nutrients for bacterial metabolism

Bacterial Signature

- *Thermus* populations fluctuate in first 24h
- *Bacteroides* in all body sites increase
- *Acinetobacter* emerge at 8h, necrotization begins

Figure 4A: Pig corpse undergoing autolysis. T= 0

Bloat

- Digestion of tissues surrounding gut
- Gases cause corpse to swell
- Onset concurrent with autolysis

Bacterial Signature

- Shift of aerobic to anaerobic bacteria
- *Proteobacteria* ≤ 80% of bacterial composition
- Anaerobes such as *Clostridium, Pseudomonas, Bacteroides, Lactobacillus* prevalent

Figure 4B: Pig corpse undergoing bloat. T= 10

Putrefaction

- Cadaverine, putrescine, hydrogen sulfide, methane
- Liquefaction of tissues
- Progressed by insects and other eukaryotes (e.g. maggots)

Bacterial Signature

- *Clostridium* and other *Firmicutes* saponify fats, forming adipocere blisters
- *Proteobacteria, Bacteroides* peak before decreasing
- Facultative anaerobes *Bifidobacteria, Actinobacteria*, *Firmicutes*

Figure 4C: Pig corpse undergoing putrefaction. T= 13

Fluid Purge

- Deflation of corpse, purge of liquefied tissues
- Tougher tissues (i.e. skin) continue decaying
- Internal environment interacts with grave site

Bacterial Signature

- *Ignatzschineria*, *Planococcaceae* opportunism
- *Acinetobacter* decrease due to pH change
- *Rhizobiales, Agrobacterium* in soil graves

Figure 4D: Pig corpse post–fluid purge. T= 23

Diagenesis

- Dry, skeletal remains
- Oxidation-reduction of minerals in bone matrix (Calcium, magnesium, potassium)
- Breakdown of collagen

Bacterial Signature

- Microaerophilic, alkaliphilic, magnetotactic species
- *Deltaproteobacteria* take advantage of high pH of grave soil
- Depends on competition with diversity in grave site

Figure 4E: Pig corpse undergoing diagenesis. T= 41+

Figure 4. The same piglet documented as decomposition progresses. T= time in days since euthanasia. A– autolysis, B– bloat, C– putrefaction, D– Fluid purge, E– diagenesis (Comstock et al. 2015).