H20 Seasonal Differences in Soil Fungal Community Successional Patterns Impacted by Long-Term Human Decomposition

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Learning Overview: After attending this presentation, attendees will better understand the joint relationship between soil chemistry and fungal successional patterns occurring during long-term human decomposition, seasonal patterns associated with these changes, and their importance for time-since-death estimations.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by improving understanding of long-term and seasonal environmental impacts of human decomposition. This presentation also has implications for Postmortem Interval (PMI) estimates and models.

Decomposition of human remains in environmental settings creates chemically and microbially active hotspots in the soil.[1,2] To date, studies of microbial dynamics in decomposition hotspots have primarily focused on characterizing successional patterns in bacterial communities during the early period of decay, associated with the greatest loss of tissue mass (i.e., active through early advanced decay). However, microbial decomposers involved in the breakdown of organic matter consist of both bacterial and fungal organisms and both are expected to play important roles during decomposition. Additionally, previous studies suggest that soil microbial communities are impacted past advanced decay, highlighting a need for long-term investigations.[2,3]

The goals of this study were to evaluate seasonal patterns in fungal succession and soil chemistry beneath decomposing human subjects for a year and in high resolution. In two seasonal trials (n=3 spring, n=3 winter), donated human subjects were placed on the soil surface at the University of Tennessee Anthropology Research Facility and allowed to decompose naturally for one year. Soils were sampled at two depths: 0–1cm (interface) and 1–15cm (core) across 20 timepoints. Amplicon sequencing was performed targeting the ITS2 region to explore fungal community patterns. Soil pH, electrical conductivity, inorganic nitrogen concentrations, dissolved oxygen, and respiration rates were measured.

Fungal successional patterns were primarily evident at the class taxonomic level. In the spring trial, relative abundances of Saccharomycetes, an Ascomycete yeast, increased between bloat through advanced decay (days 8–72) comprising, on average, approximately 75% of the community in interfaces and 50% in core soils. In the winter trial, Saccharomycetes increased in relative abundance during advanced decay (days 75–110), but with maximum relative abundances of just 25%. Following Saccharomycetes enrichment, Sordariomycetes increased to become the single dominant class, with relative abundances around 25% (spring) and 25%–40% (winter) for the remainder of the study. The Sordariomycetes enrichment was largely due to increases in the orders Hypocreales and Microascales.

Principal Coordinates Analysis (PCoA) shows that fungal community shifts differed significantly by study day and morphological decomposition stage during both seasons (Permutational Multivariate Analysis Of Variance [PERMANOVA], $p < 0.05$). The successional trajectory, as visualized on ordination plots, had two inflection points: (1) the onset of advanced decay (spring, day 16), which corresponded to decreased pH, increased conductivity and respiration rates, maximum ammonium concentrations, and minimum soil oxygen levels ($38.9 \pm 10\%$); and (2) between days 16–86 (spring) corresponding to 85% soil oxygen, decreased ammonium concentrations, and elevated nitrate concentrations.

The observations of fungal community shifts co-occurring with changes in soil oxygenation and inorganic nitrogen speciation show that fungal community and soil chemistry changes are inextricably linked in decomposition hotspots; however, these changes varied by magnitude and timing between seasons.

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Reference(s):

1. Keenan, S.W., Emmons, A.L., Taylor, L.S., Phillips, G., Mason, A.R., Mundorff, A.Z., Bernard, E.C., Dovoren, J., DeBruyn, J.M. (2018). Spatial Impacts of a Multi-Individual Grave on Microbial and Microfaunal Communities and Soil Biogeochemistry. *PLoS ONE*. 13(12):e0208845.
2. Cobaugh, K.L., Schaeffer, S.M., DeBruyn, J.M. (2015). Functional and Structural Succession of Soil Microbial Communities below Decomposing Human Cadavers. *PLoS ONE*. 10(6):e0130201.
3. Singh, B., Minick, K.J., Strickland, M.S., Wickings, K.G., Crippen, T.L., Tarone, A.M., Benbow, M.E., Sufrin, N., Tomberlin, J.K., Pechal, J.L. (2018). Temporal and Spatial Impact of Human Cadaver Decomposition on Soil Bacterial and Arthropod Community Structure and Function. *Frontiers in Microbiology* 8:2616.

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