H36 Spatial and Temporal Variability in Soils — Their Importance for Intelligence and Forensic Application

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After attending this presentation, attendees will understand the potential of soil metagenomic profiling for determination of soil provenance. This presentation will illustrate the microbial patterns, specifically their spatial and temporal variability, in the soils while demonstrating to attendees the effectiveness of using microbial profiling compared to abiotic information for forensic applications.

This presentation will impact the forensic science community by demonstrating the potential of soil metagenomic profiling to assist in the identification of the soil's geographic location. This presentation will demonstrate the spatial and temporal variability of both biotic and abiotic data in soil, thereby illustrating the effectiveness of soil biotic data for use in forensic applications.

A vast array of information, both abiotic and biotic, is associated with soils. The current ecological hypothesis is that soil type (i.e., chemical/physical properties) is correlated to the community of microbes that inhabit that particular soil type.[1] Therefore, soil metagenomic profiling should produce a distinguishable biotic profile from a specific soil type from a particular geographic location and subsequent DNA and bioinformatics analyses of the soil community could provide a rapid method for soil provenance; however, the intrinsic spatio-temporal heterogeneity of soil also needs to be considered in the community analyses.[2] Microbial patterns as well as the spatial scale relationship between microbial community composition and environmental variables are largely unknown and it is important to understand these interrelationships for both ecological knowledge and for forensic applications.[3] Microbial profiling effectiveness is dependent on the uniqueness among different habitat types, level of heterogeneity within a habitat, and stochastic processes in community over time.

In this study, bacteria, archaea, fungi, and plant universal DNA markers were polymerase chain reaction-amplified, separated by capillary electrophoresis and queried across six soil types in Miami-Dade County, FL, over two seasons (dry and wet; 2010-2011) and again four years later (2014). Abiotic information such as pH, inorganic/organic matter content, content, soil texture (% sand, % silt, % clay), and moisture content was obtained from the soil. Modeling approaches using geographic information systems were employed to study the soil processes and patterns by observing their spatial and temporal distribution using both abiotic and biotic information. The range of the various parameters across seasons (e.g., moisture content: dry=12.69-57.83%; wet=14.26-70.19%; pH: dry=7.15-7.94, wet=6.90-7.73) were correlated to the geographic location and soil type from which they were sampled. For the 2014 dry season, organic content ranged from 6.01%-38.31%, inorganic from 61.67%-93.99%, and carbon 3.01%-19.16%. The organic/inorganic and carbon data are pending for the 2014 wet season.

Soils should display limited temporal variability, in that soils should not change substantially over time, to be able to use pattern modeling for forensic or provenance applications. Bioinformatic algorithms (i.e., random forests and decision trees) were able to classify soils from a particular geographic location with >98% accuracy. The data from this study will add to that soil classification database and will be assessed for the ability to classify soils collected four years apart. These data then strongly verify the use of microbial profiling for provenance of soil.

References:

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2. Meyers, M. S., & Foran, D. R. (2008). Spatial and temporal influences on bacterial profiling of forensic soil samples. Journal of Forensic Sciences, 53(3), 652-660.
3. Sensabaugh, G. F. (2009). Microbial community profiling for the characterisation of soil evidence: Forensic considerations. In K. Ritz, L. Dawson & D. Miller (Eds.), Criminal and environmental soil forensics (pp. 49-60). Berkeley, CA: Springer

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