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Forensic Taphonomy:

processes associated with cadaver decomposition in soil

David O. Carter

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School of Pharmacy and Molecular Sciences

James Cook University

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David O. Carter

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ABSTRACT

A series of laboratory and field incubations were carried out where juvenile rat (*Rattus rattus*) cadavers were buried in three soils of contrasting texture from tropical savanna ecosystems in Queensland, Australia. This work was done in order to develop an understanding of the effect of environmental variables (temperature, moisture), the soil in which a cadaver is buried and the nature of the cadaver on the processes associated with cadaver decomposition in soil. A pattern of mass loss comprised of an "Early Phase" of slow mass loss, "Intermediate Phase" of rapid mass loss and a "Late Phase" of slow mass loss. Early Phase decomposition coincided with an initial increase in carbon dioxide (CO_2) evolution, microbial biomass carbon (C_{mic}), phosphodiesterase activity, protease activity and soil pH. Microbial activity was triggered within 24 hours of cadaver burial and this initial flush of activity was likely due to both soil-borne and cadaveric microbes. Intermediate Phase decomposition was typically associated with peak levels of CO_2 evolution, C_{mic}, phosphodiesterase activity and soil pH. Late Phase decomposition typically coincided with a slowing down of process rates. In some cases, however, peak levels of protease activity were observed during late phase decomposition.

The rate of cadaver decomposition increased with an increase in temperature and moisture. However, the rate of cadaver decomposition was slowed at a matric potential of –0.3 megapascals (MPa) in coarse-textured soil and a matric potential of –0.01 MPa in fine-textured soil. Temperature and moisture also had similar effects on CO_2 evolution, C_{mic}, protease activity, phosphodiesterase activity and soil pH. In addition, the soil matrix and the soil microbial biomass had a significant effect on cadaver decomposition. The rate of cadaver decomposition following

burial in soil was greater than when a cadaver was exposed to a sterile, soil-free environment. Furthermore, cadaver decomposition was greatest in sandy soil. These phenomena were likely due to a greater rate of gas diffusion associated with sandy soil and the activity of aerobic microorganisms. The activity of aerobic decomposers was reflected as a significant relationship between CO_2 evolution and cadaver mass loss.

The structure of the soil microbial community determined by analysis of phospholipid fatty acids (PLFAs) was affected by the presence of a cadaver. However, soil type and seasonal variation in temperature and moisture had a much greater effect on the soil microbial community. In addition, the current study provided more evidence to show that the structure of the soil microbial community can be related to the function (protease, phosphodiesterase activity) of the soil microbial community. Furthermore, temporal changes in the microbial community of gravesoils were also observed.

Te results from the laboratory incubations were used to interpret the results from the field incubations. However, some results differed between laboratory and field settings. The rate of cadaver mass loss was greater in a field setting. Also, cadaver decomposition was greatest in sandy soil in the laboratory while cadaver mass loss was greatest in clay soil in the field. Moreover, changes in soil pH and the concentration of ammonium were less in a field setting.

The current thesis has demonstrated that the introduction of a cadaver into the soil can have a significant effect on the biological and chemical characteristics of soils.

In turn, this phenomenon can be affected by environmental variables, the soil in which a cadaver is placed and the nature of the cadaver. Biological and chemical measurements conducted in the current study hold potential for forensic applications, including markers of clandestine graves and a basis for the estimation of postmortem and postburial intervals.

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ABBREVIATIONS

ACE	Aerobic catabolic efficiency
C_{mic}	Microbial biomass carbon
CI	Incised, stitched cadaver
CO_2	carbon dioxide
EC	Eviscerated cadaver
FA	Yabulu/FACE site
MPa	Megapascals
NH_4^+-N	Ammonium-nitrogen
NO_3^--N	Nitrate-nitrogen
PLFA	Phospholipid fatty acid
PR	Pallarenda site
qCO_2	Metabolic quotient
SIR	Substrate-induced respiration
WB	Wambiana site