Chapter 20
Research in Forensic Taphonomy: A Soil-Based Perspective

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Abstract Forensic taphonomy is the use of processes associated with cadaver decomposition in the investigation of crime. For example, these processes have been used to estimate post-mortem interval, estimate post-burial interval and locate clandestine graves. In recent years, significant advances have provided a better understanding of cadaver decomposition and its effect on associated soil (gravesoil). These are reviewed in the context of soil-based information. In this chapter, we consider the effect of a cadaver on gravesoil and how these processes might be used in the legal system. In addition, we attempt to introduce the idea of contrived, experimental work to forensic taphonomy.

Introduction

Significant advances have been made in the decade since Haglund and Sorg (1997a) released their landmark text on forensic taphonomy. Estimates of post-mortem interval have improved through a better understanding of intrinsic cadaver decomposition processes (Vass et al. 2002) and the development of forensically important insects (Higley and Haskell 2001; Huntington et al. 2007). More effective methods to locate clandestine graves have resulted from a more detailed understanding of the effects that a cadaver has on the environment (Carter and Tibbett 2003; Lasseter et al. 2003; Vass et al. 2004; Carter et al. 2007; Carter et al. 2008a), while improved determinations of cause and manner of death have resulted from investigation into the taphonomic changes associated with trauma (Calce and Rogers 2007). Yet despite

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these significant contributions to forensic taphonomy, an extensive gap in knowledge exists in the relationship between cadaver decomposition and soil, particularly soil biology and chemistry.

The poor understanding of decomposition processes in gravesoils is due to several factors. Most research in forensic taphonomy has focused on pathology (e.g. Clark et al. 1997), entomology (e.g. Nabity et al. 2006) and anthropology (e.g. Calce and Rogers 2007) rather than soil processes. This approach is arguably justified, as many death investigations occur in urban settings (e.g. within buildings) rather than in or on soil. However, when soil is used as physical evidence, it is typically used as associative evidence (see Fitzpatrick 2008) rather than as a medium with which to understand cadaver decomposition. Soil as associative evidence has assisted countless criminal investigations but it represents only a part of what soils can contribute, particularly in areas of low population density where a cadaver can be left to decompose in association with gravesoil for several weeks or years. Therefore, to maximise the forensic potential of soils, it is necessary to investigate the processes associated with cadaver decomposition in gravesoils. To contribute toward this goal, the purpose of this paper is to (1) discuss new ways that soils might contribute to forensic taphonomy and (2) attempt to introduce the concept of contrived, replicated, experimental work to forensic taphonomy rather than a reliance on case studies and anecdotal evidence. Thus, this chapter will emphasise the knowledge that soils might contribute to forensic taphonomy and the need for taphonomy to use properly designed experimental studies to address major questions in cadaver breakdown.

Gravesoil Processes

In reality, cadaver decomposition is a dynamic process that begins at the time of death and continues until all cadaver components have been cycled into the wider ecosystem. Although this is a continual process, many stages of decomposition have been proposed in an attempt to help understand what occurs during the breakdown of a cadaveric resource (Fuller 1934; Bornemissza 1957; Payne 1965; Payne and King 1968; Vass et al. 1992). Recent research has shown that a cadaver can have a significant effect on the biology and chemistry of associated soils and these effects can change as cadaver decomposition proceeds (Table 20.1).

Aboveground Decomposition

The first stage of decomposition, Fresh, is associated with little change in gravesoil biology and biochemistry other than that which can result from soil disturbance. Typically, soil disturbance tends to result in a brief increase in soil microbial activity (e.g. Carter et al. 2008b), as it exposes previously unavailable food sources and

Table 20.1 Stages of above ground cadaver decomposition (after Payne 1965) and their effect on associated soil (gravesoil). Volatile fatty acids include propionic, iso-butyric, n-butyric, iso-valeric and n-valeric acid (Vass et al. 1992)

Stage of decomposition	Effect on soil	References
Fresh	Initial disturbance	
Bloat	Initial introduction of cadaveric fluids from mouth, nose, anus, ears and increase in nutrient concentration and pH: Ammonium Calcium Chloride Magnesium Ninhydrin-reactive nitrogen potassium Sodium Sulphate Volatile fatty acids	Vass et al. (1992); Spicka et al. (2008)
Active decay	Increased concentration of nutrients and pH: See Bloat Ninhydrin-reactive nitrogen Volatile fatty acids	Vass et al. (1992); Spicka et al. (2008)
Advanced decay	Peak levels of gravesoil nutrient concentrations and soil pH: See Bloat Ninhydrin-reactive nitrogen Volatile fatty acids	Vass et al. (1992); Spicka et al. (2008)
Dry and remains	Gradual decrease in nutrient concentration levels and gravesoil pH with elevated levels of: Ammonium Calcium Carbon (total) Chloride Nitrate Nitrogen (total) Phosphorus (Bray) Phosphate Potassium Sodium Volatile fatty acids	Vass et al. (1992); Towne (2000); Danell et al. (2002); Melis et al. (2007)

results in the death of microbial cells, which are also used as food by living microbes. As the enteric micro-organisms break down the cadaver, evolved gases result in the bloating of the cadaver and the initial release of cadaveric fluids into gravesoil, which might represent the initial change in gravesoil chemistry and biology. This initial change, thus far observed as an increase in the concentration of ninhydrin reactive nitrogen, can occur as early as 48 h after death during the

warm summer months (Spicka et al. 2008). During this initial release of cadaveric fluids, maggot activity will reach its peak, thus designating the onset of Active Decay. This stage is associated with the majority of cadaver mass loss, some of which is introduced into gravesoil. Although cadaveric materials are being introduced into gravesoil during Active Decay, peak nutrient concentrations are associated with Advanced Decay (Vass et al. 1992; Carter and Tibbett 2008) (Table 20.1). Advanced Decay begins with the migration of the blow fly larvae from the cadaver. The Dry and Remains stages are the final stages of decomposition and it is currently understood that nutrient concentrations remain elevated, but it is not known how long this effect can persist. Sagara et al. (2008) have reported that the post-putrefaction fungi can form fruiting structures for up to 10 years following soil nutrient amendment. Fungi have been observed in association with above ground cadaver decomposition as soon as one month post-mortem (Carter et al. 2007). Thus, this phenomenon might indicate an extended persistence of elevated nutrient concentration in gravesoil.

Belowground Decomposition

Decomposition processes in gravesoil following burial has received less experimental attention than above ground decomposition. Payne and King (1968) proposed an alternative set of decomposition terminology because the decomposition in these two settings is sufficiently different (Table 20.2). This is primarily due to the absence of insects and scavengers. Thus, below ground decomposition is primarily mediated by micro-organisms and proceeds less rapidly than above ground decomposition. It has been estimated that burial results in a rate of decomposition that is eight times slower than above ground decomposition (see Rodriguez 1997). However, there is no experimental evidence to support this estimation. (For a more detailed description of below ground cadaver decomposition see Payne et al. 1968; Fiedler and Graw 2003; Dent et al. 2004.)

The initial stages of belowground decomposition, Fresh and Inflated, proceed similarly to the Fresh and Bloat stages observed above ground. During the Inflated stage, fluids are first introduced to the soil. This introduction, combined with the initial disturbance of the soil, results in an increase in soil microbial activity (Carter et al. in 2008b) (Table 20.2). The third stage however, Deflation and Decomposition, represents the time when most of the fluids are released into the soil (Payne et al. 1968). These fluids are released from natural orifices including the mouth, nose, anus, and ears and these fluids can support the initial proliferation of bacterial and fungal communities (Payne et al. 1968). This growth in the soil microbial biomass has been associated with enhanced protease and phosphodiesterase activity (Carter et al. in press). These extracellular enzymes are released to decompose protein and nucleic acids, respectively. By the fourth stage, Disintegration, bacteria and fungi can cover the cadaver completely (Payne et al. 1968). In addition, Payne et al. (1968) observed soil mites and collembola first appear during this stage. If flies are able to colonise a buried cadaver,

Table 20.2 Stages of below ground cadaver decomposition (after Payne et al. 1968) and their effect on associated soil (gravesoil)

Stage of decomposition	Effect on soil	References
Fresh	Initial disturbance associated with increased soil microbial activity (carbon dioxide respiration)	Carter et al. (in press)
Inflated	Initial release of decomposition fluids into soil result in elevated: Carbon dioxide (CO_2) Soil pH	Payne et al. (1968); Wilson et al. (2007); Carter et al. (2008b)
Deflation and decomposition	Peak release of decomposition fluids into soil associated with elevated: Electrical conductivity CO_2 Microbial biomass Protease Phosphodiesterase Soil pH	Payne et al. (1968); Carter et al. (2008b); Wilson et al. (2007); Janaway et al. (this chapter 22)
Disintegration	Established bacterial and fungal colonies with gradual decline in microbial activity. Elevated levels of: CO_2 Microbial biomass Protease Phosphodiesterase Soil pH	Payne et al. (1968); Wilson et al. (2007); Carter et al. (2008b)
Skeletonization	Elevated levels of: Ammonium Amino acid N CO_2 Total C Total N Microbial biomass Protease Phosphodiesterase Soil pH	Hopkins et al. (2000); Rapp et al. (2006); Wilson et al. 2007; Carter et al. (2008b)

maggot migration will occur at the end of Disintegration. The final stage of below ground decomposition, Skeletonisation, represents the period when the primary cadaveric carbon sources are hair, skin and nails. These cadaver components, as well as bone, occupy an island of soil that has been stained by decomposition fluids containing

carbon and nitrogen, which can result in an increased nutrient concentration and soil microbial biomass for over 400 days following burial (Hopkins et al. 2000).

Potential Contributions from a Soil-Based Approach

Gravesoil is a complex and dynamic system of interdependent chemical, physical and biological processes that can be significantly affected by cadaver decomposition. Tables 20.1 and 2 clearly show that several biological and chemical changes occur in gravesoil as a body decomposes. However, only some of these phenomena have been investigated for forensic use. A more detailed understanding of gravesoil processes will likely contribute to forensic science in three primary areas: improved estimates of post-mortem interval and post-burial interval and enhanced methods to locate clandestine graves and gravesoils.

Estimation of Post-mortem Interval and Post-burial Interval

An accurate estimation of post-mortem interval (PMI) is one central objective to any medico-legal investigation of death, equal to victim identification and cause of death. Estimation of the PMI can direct or re-orientate an investigation by serving to accept or reject an alibi or elucidate the peri-mortem activities of a victim. Pathology, anthropology and entomology, from oldest to most recent, have developed criteria to enhance the estimation of PMI (Forbes 2008). Traditionally, in early post-mortem time the pathologist best ascertained the PMI using the soft tissue indicators of *rigor mortis, livor mortis* and *algor mortis* (DiMaio and Dana 2006). As the interval lengthens to include the visual cues of numerous gross morphological attributes of decomposition (i.e. bloating, discoloration, etc.), anthropology has become increasingly contributory at PMI estimation by temperature correlation (Megyesi et al. 2005). Most successful at the estimation of the PMI, overlapping pathology and anthropology, is entomology, which uses the developmental biology of blowflies (Higley and Haskell 2001).

Gravesoil research holds promise as it may provide a rapid and reliable technique to estimate PMI and help control for the increasing time error that accompanies extended decomposition stages. At present, only two soil-based techniques are available for the estimation of early PMI. The technique developed by Vass et al. (1992) to analyse fatty acids and nutrients can be used to estimate PMI from immediately following death to several years post mortem. In addition, Spicka et al. (2008) demonstrated that the concentration of ninhydrin-reactive nitrogen in gravesoil associated with juvenile to adult sized cadavers (20–50 kg) remains at basal levels until two days post mortem. This phenomenon can be used estimate early PMI when a fresh cadaver has been discovered, i.e. if the concentration of ninhydrin reactive nitrogen is similar to control values then the cadaver has been dead for less than two days.

Although forensic entomology is arguably the most successful way to estimate PMI, blow fly larvae are at their greatest forensic value up until Advanced Decay (see Payne 1965), which can occur as soon as 10 to 14 days after death in warmer months. As a consequence, forensic taphonomy lacks a precise method to estimate PMI once fly larvae have begun to pupate. This is a particular problem in rural areas where bodies can go undetected for several months following death. The time period that follows Advanced Decay, the extended PMI, is where gravesoil processes will likely have their greatest forensic impact. At present, few techniques exist to estimate extended PMI using soils. As mentioned above, the Vass et al. (1992) method has been developed. Another potential area of emphasis is the ecology of the post-putrefaction fungi (Sagara 1995). These fungi form fruiting structures in response to the cadaver breakdown and have been observed to fruit in two successional phases: Phase I fruits from 1 to 10 months post mortem while Phase II fruits from one year to four years post mortem. Although the forensic use of the fungi requires more detailed research, it might find successful use in cases where bodies have been missing for several years. Thus, a great need exists to develop rapid, reliable, and inexpensive techniques that use the biology and chemistry of gravesoil as a basis to estimate postmortem interval of cadavers that decompose above ground.

Some of the cadavers that are disposed of in terrestrial ecosystems are buried in soil. As a consequence, there is a great need for cadaver decomposition studies to investigate the gravesoil processes associated with buried cadavers. Perpetrators of crimes rely on the decomposition of corpses to hinder identification and obscure estimates of PMI or post-burial interval (PBI). Burial can greatly confound current methods of estimating PMI, such as entomology (Turner and Wiltshire 1999), because it often prevents the ability of insects and scavengers to access a cadaver as a resource. Thus, decomposition rates on the soil surface do not represent decomposition that occurs belowground. To further complicate matters, it is not uncommon for a body to be dead for some length of time prior to burial. Thus, PMI and PBI can be quite different (Forbes 2008). At present, only plant growth (Haglund and Sorg 1997b), palynology (Szibor et al. 1998), and microbial activity (Tibbett et al. 2004; Sagara et al. 2008) have been investigated as potential means to estimate PBI. However, the approaches described for above ground decomposition will likely provide insight into the relationships between edaphic parameters and the estimation of PBI. They simply must be tested on gravesoils associated with buried bodies.

It has been stated above that forensic entomology currently provides the most accurate way to estimate PMI. This is due to two primary factors: (1) blow flies can arrive at, and oviposit on, a cadaver within seconds of death (Mann et al. 1990) and (2) the development of these insect larvae is positively correlated to temperature (Higley and Haskell 2001). Thus, the estimation of PMI requires the determination of the age of the blow fly larvae along with a record of temperatures at the scene. This relationship has resulted in the regular use of accumulated degree days (ADDs) by forensic entomology. Of the soil-based cadaver decomposition studies, only Vass et al. (1992) and Carter et al. (2008b) have considered the use of ADDs. However, they might play a significant role in the development of further soil-based forensic methods. Vass et al. (1992) have demonstrated a significant relationship between temperature and gravesoil

chemistry and a similar relationship might exist between temperature and gravesoil biology. Like insects, soil microbes respond to cadaver introduction in a short period of time (<24 h) (Carter et al. 2008b). Thus, if a relationship between temperature, cadaver decomposition and soil ecology is to be developed, it might make significant contributions to the estimations of extended PMI.

Location of Clandestine Graves

It is not uncommon for an investigative agency to be aware that a clandestine grave exists, yet be unable to find it. As a consequence, several methods have been developed to locate human remains, whether they are on or in soil (see Killam 1990). Ultimately, these techniques aim to detect the changes that occur once a body is placed in a terrestrial ecosystem. Typically, the search for a clandestine grave is conducted in two stages. The first stage uses as little intrusion into the soil as possible. The most common methods include geophysical techniques (e.g. ground penetrating radar) (Schultz 2008) and the use of cadaver dogs (Lasseter et al. 2003) that detect changes in soil physics and chemistry, respectively. In addition, Vass et al. (2004, 2008) have recently developed an instrument to analyse the decomposition gases released from a cadaver during decomposition. Less common is the identification of the post-putrefaction fungi, although it represents a low-cost method for the detection of buried mammalian remains.

Following the detection of putative clandestine graves, soil samples are collected and tested to determine if intrusive exploration will occur. Due to the wide range of chemical and biological effects that a cadaver has on gravesoil following burial (Table 20.2), there is great potential for the development of a soil-based method to locate clandestine graves. Potential methods include each of those discussed for the estimation of PMI. If cadaver decomposition results in a significant change in gravesoil ecology, then fatty acids, nutrients, and carbon can be used to detect gravesoil. However, the measurement of ninhydrin reactive nitrogen (Carter et al. 2008a; Carter et al., Chapter 21) is currently the most rapid, inexpensive and simple method to presumptively test for gravesoil.

Considering Environmental and Edaphic Parameters: The Need for Experimental Research

While soil has been much studied as a decomposition environment for materials of relatively little forensic value such as leaf litter or dead roots (Cadisch and Giller 1997), there is clearly a need for experimental forensic taphonomy to provide rigorously tested information to practitioners and the courts to better understand gravesoils. However, forensic taphonomy must deal with the problem that it is difficult to acquire human cadavers for experimental use. Also, it is impossible to replicate human cadavers. This results in statistical deficiencies and a tendency to

disturb cadavers during sampling, which can have a significant effect on the rate of decomposition (Adlam and Simmons 2007). Thus, it is necessary to conduct field- and laboratory-based research using human cadaver analogues, while continuing to use information from human cadaver decomposition studies and case studies.

However, experimental studies of the decomposition of human cadavers under controlled conditions have rarely been published. Field studies, occasionally using human bodies (Rodriguez and Bass 1983; Rodriguez and Bass 1985) but, more commonly, animal surrogates have been undertaken (Payne 1965; Payne et al. 1968; Micozzi 1986; Turner and Wiltshire 1999; Forbes et al. 2005c; Carter et al. 2008a). However, knowledge of the decomposition processes and the influence of the environment and edaphic parameters are limited because the primary sources of information are case studies and empirical evidence (Motter 1898; Mant 1950; Morovic-Budak 1965; Spennemann and Franke 1995). As a consequence, edaphic parameters were recognised as having little influence (Mant 1950; Morovic-Budak 1965; Mant 1987) on cadaver decomposition until the early 21st century (Fiedler and Graw 2003; Forbes et al. 2005a; Carter et al. 2008a).

It is now becoming increasingly apparent that the effect of the type of soil and prevailing environmental conditions can have a profound effect in the rate of cadaver decomposition and hence estimates of PMI, PBI and gravesoil detection (Forbes et al. 2005a,b; Wilson et al. 2007; Carter et al. 2008b). Examples of some basic soil characteristics that might affect the rate of cadaver decomposition include: physical texture (whether the soil is sandy, silty or clayey can profoundly affect the rate of decomposition by limiting the movement of gases and water to and from the cadaver); chemistry (the acidity or alkalinity of a soil may affect decomposition); and biological activity (a soil with an active faunal population may have the capacity to decompose cadaveric tissue more quickly) (Fiedler and Graw 2003). The key environmental parameters that need consideration are temperature and moisture (the main determinants of climate). The key edaphic parameters are less clear but are likely to include soil pH, salinity, redox potential and nutrient status.

Environmental Effects

Environmental determinants can have a critical effect on cadaver decomposition. For example, if the environment is permanently frozen or waterlogged, there can be close to zero decomposition and, by contrast, optimised conditions for temperature and moisture can lead to very rapid decomposition. In addition, recent work has shown that specific microenvironments can promote or delay the rate of cadaver decomposition in soils c.f. Janaway et al., Chapter 22. Currently better estimates can be made of the effect of environmental parameters compared with edaphic parameters on the rate of cadaver decomposition; however, there remains a paucity of experimental evidence to support these estimates, at least in the peer-reviewed literature.

Few published experiments investigate the effect of soil temperature on the rate of decomposition of cadaveric material (Carter and Tibbett 2006; Carter et al.2008b.

Table 20.3 Temperature coefficients (Q_{10} values ± SE) of carbon dioxide respiration in a sandy loam soil (100 g dry weight calibrated to 60% water holding capacity) of the Fyfield series, Lindens Farm, East Lulworth, Dorset, England following the burial of 1.5 g skeletal muscle tissue (Ovis aries). After Carter and Tibbett (2006)

Q_{10}	Day 21	Day 42
2 °C–12 °C	2.9 ± 0.1	2.5 ± 0.1
12 °C–22 °C	1.8 ± 0.1	1.5 ± 0.10

In one of these studies (Carter and Tibbett 2006) the effect of three temperature regimes (2 °C, 12 °C, 22 °C) was examined. The results provided the first definitive data of the effect of temperature on the rate of mammalian tissue decomposition in soil (see Table 20.3). The data show quite clearly that (for this soil type) decomposition rate can vary greatly with temperature (there was ca. 60% difference in the rate of mass loss between 2 °C and 22 °C after 14 days), yet that even at a very low temperature (2 °C), decomposition can proceed at a significant rate. This type of study is laboratory based, as it is difficult (and expensive) to control environmental parameters in a field setting. However, this study also highlights the potential for the use of ADDs in forensic soil science. As stated previously, further detailed experimental work should demonstrate whether ADDs can be applied to soil processes and used for the accurate estimation of PMI and PBI.

Edaphic Effects

Few examples exist where replicated experimental work has been carried out to quantify the effects of different edaphic characteristics on decomposition. One such study considered the effect of different soils of contrasting pH on the decomposition of skeletal muscle tissue (Haslam and Tibbett, unpublished data). In this study two types of soil were compared. One soil type, rendzina, had alkaline pH (7.8) the other type, podsol, had an acid pH (4.6) (Figure 20.1). The rate of decomposition of skeletal mammalian muscle tissue (1.5 g – cuboid) was measured along with any changes to the soil pH over the course of a six-week incubation. The methods used followed those described elsewhere (Tibbett et al. 2004) and organic lamb (Ovis aries) was used as an analogue for human tissue.

The results of this experiment have led to three important findings with some interesting implications for forensic taphonomy (Figures 20.1 and 20.2). Firstly, the study confirmed what had previously been described; that soil pH increases in the presence of a decomposing cadaver (Rodriguez and Bass 1985). This is thought to be due to the release of ammonium ions (Hopkins et al. 2000), a suggestion for which we have recently acquired supporting evidence (Stokes, Forbes and Tibbett, unpublished data). Secondly, that the autochthonous soil pH has a profound effect on the subsequent change caused by muscle tissue decomposition. In an alkaline

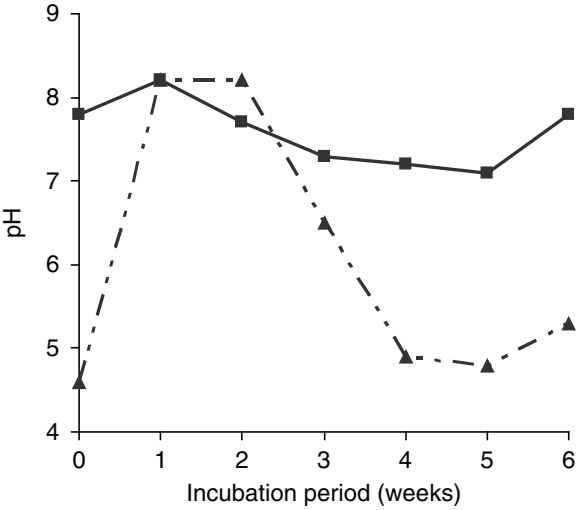

Fig. 20.1 The effect of burial of mammalian muscle tissue (*Ovis aries*) on soil pH in an acid soil (podsol, pH 4.6 – triangles and dashed line) and an alkaline soil (rendzina, pH 7.8 – squares with solid line) (Haslam and Tibbett, unpublished data)

soil, pH did not change by much, whereas in an acidic soil, pH rose by over three units. Thirdly, the dynamics of decomposition (the rate of mass loss) were different in the contrasting soils. Between two and three weeks the muscle tissue in the acidic podsol had decomposed twice as fast as in the alkaline rendzina. By the end of the experiment (six weeks), the muscle tissue in the podsol had completely decomposed whereas there was still a residual muscle tissue in the rendzina soil.

This type of experimental evidence begins to develop some predictive power to soil-based data, so that for a given soil type we may anticipate a particular decomposition dynamic and timeframe. However, the data may also be used retrospectively and will allow more scientifically sound estimates of PMI and PBI, especially for buried cadavers.

The experiment described above is not of the type that can directly be used in court tomorrow, however, it provides a framework for more predictive 'real-world' experiments with cadavers and in the field. These type of experiments are clearly more expensive and time consuming and it is up to the research funding agencies (including the law and order agencies) to step up the level of funding to an appropriate scale to allow real progress to be made to provide high quality experimental evidence that is admissible in court.

Admissibility of Soil Evidence

Ultimately, forensic taphonomy aims to contribute to criminal proceedings. Thus, the science must be admissible in a court of law, regardless of whether it is presented

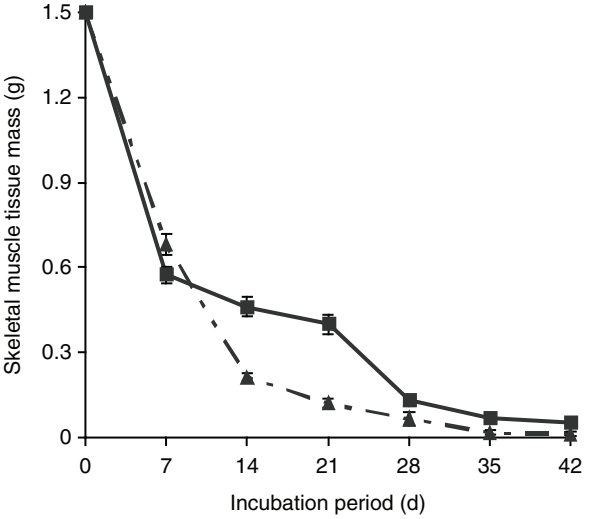

Fig. 20.2 The rate of mass loss (decomposition) of mammalian muscle tissue (*Ovis aries*) when buried in two soils on contrasting pH. The two soils were an acidic soil (podsol, pH 4.6 – triangles and dashed line) and an alkaline soil (rendzina, pH 7.8 – squares with solid line) (Haslam and Tibbett, unpublished data)

at trial or not. The admissibility of physical evidence has been a subject of great interest in the recent past (Kiely 2006), particularly in the USA. The federal ruling Daubert v Merrell Dow Pharmaceuticals, 1993, which has been adopted by several US states, established judges as the arbiters of scientific rigour and legal admissibility. Briefly, judges determine whether or not physical evidence is admissible by using the following guidelines: (i) can the science be replicated and tested? (ii) has the science been published in a peer-reviewed journal? (iii) does the science have known error rates and established standards? (iv) is the science generally accepted by the relevant scientific community and taught at university?

These guidelines for admissibility clearly show that, although case studies and anecdotal evidence can be published and their content can be taught at university, they typically cannot provide data regarding error rates or represent an established standard. Quite simply, forensic taphonomy must move toward the implementation of a contrived, replicated experimental approach if it is to garner future use in the legal system.

Conclusions

Forensic taphonomy holds great potential to contribute to the estimation of post-mortem interval, estimation of postburial interval, and location of clandestine graves (Carter and Tibbett 2008). Current research is starting to fill in the gaps in knowledge

that inevitably exist in developing areas of science such as this. As a multidisciplinary science, forensic taphonomy requires contributions from anthropologists, entomologists, soil scientists, microbiologists, biochemists and chemists to work together in the exciting and expanding frontier of forensics. Currently, too little is known in forensic taphonomy from experimental research, and the science is, to date, dependant on the experience of practitioners and the logical inferences and estimates from carefully examined case studies. Although this dependence is understandable, the time has now come for forensic taphonomy to rely primarily on contrived experimental work, and an increasing number of studies are now based on carefully designed experimental protocols in the laboratory and field that should provide the forensic practitioner with more a robust science on which to base research that is admitted into the courtroom.

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