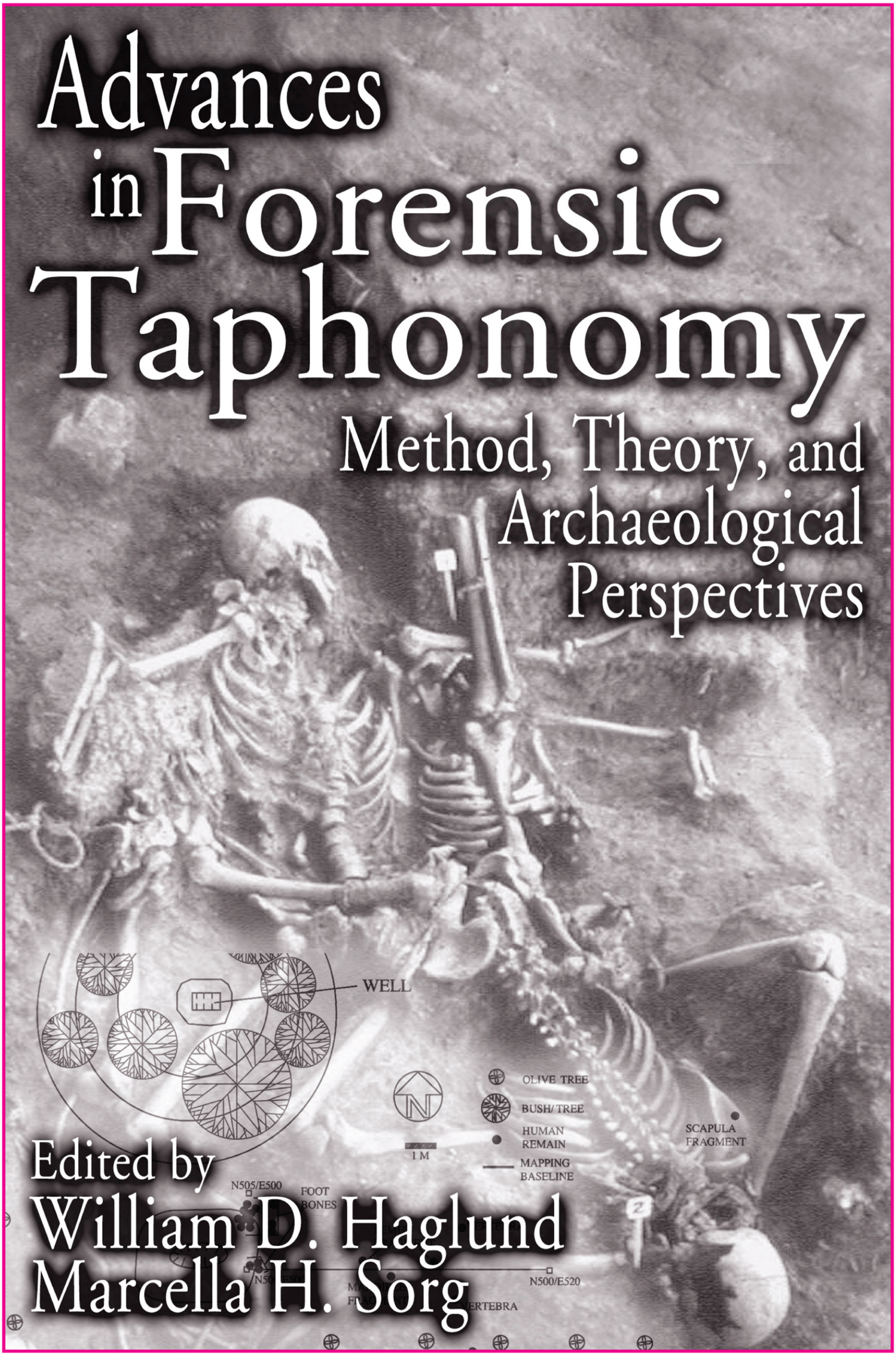
Advances in Forensic Taphonomy

Method, Theory, and Archaeological Perspectives



Edited by
William D. Haglund
Marcella H. Sorg

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Preface

It is only when viewed through the interdisciplinary lens that the full value of forensic taphonomy can be realized. Thus, we began the volume with a tri-partite foreword that is meant to be an integral part of this volume. These three contributions convey the perspectives of eminent spokespersons from pathology, anthropology/archaeology, and paleontology: the primary disciplines upon which taphonomy is based. Each author underscores the interdisciplinary nature of the field and, in the case of Hunter, presents a timely international perspective.

Forensic pathologist Donald Reay speaks to the compatibility of collecting taphonomic data in the context of contemporary death investigations, its non-intrusiveness to the investigation process, and its potential contribution of broader-based data sets. He spreads a welcome mat to taphonomic approaches that is founded on personal experience and an enlightened vision.

Lee Lyman, archaeologist and a leader in articulating taphonomic theory, points to what we believe is the seminal contribution that contemporary death investigation can repay to archaeology and paleontology. That is, a high-resolution perspective provided by actualistic experience in the time period spanning the "realms of flesh," from the time of death through decomposition, and the flesh's disappearance. Lyman further suggests a deeper, theoretical contribution of forensic taphonomy: its emphasis on positive findings (taphonomic data as evidence) as opposed to the more usual approach in paleontology of viewing taphonomic characteristics as a bias one must strip away to get to the truth.

John Hunter offers a refreshing historical view of the recognition and growing pains of "forensic archaeology" in Great Britain. He also touches on the paradigm difference between the United Kingdom and the United States in the teaching of archaeology/anthropology. We would hope this makes more salient our sometimes provincial tendencies, characteristics we must confront more and more as we meet on the international stage to ply our professions.

In addition to the bedrock disciplines of taphonomy, contributions to these pages also come from molecular biology, entomology, oceanography, criminal investigation, and philosophy — and from several authors outside the United States. Thus, it is in the spirit of interdisciplinary and international collaboration that we offer this volume.

William D. Haglund, Ph.D.
Marcella H. Sorg, Ph.D., D.A.B.F.A.

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The Editors

William D. Haglund, Ph.D., received his B.A. degree in biology from the University of California, Irvine, and his Ph.D. in physical anthropology from the University of Washington, Seattle. He served as Chief Medical Investigator of the King County Medical Examiner's Office, Seattle, Washington, for 14 years. In December 1995 he became the United Nations' Senior Forensic Advisor for the International Criminal Tribunals for Rwanda and the former Yugoslavia. He is presently Director of the International forensic Program for Physicians for Human Rights, a Boston-based non-governmental organization. He has conducted forensic missions in numerous countries, including Guatemala, Honduras, Rwanda, Somaliland, Georgia/Abkhazia, the former Yugoslavia, Cyprus, Sri Lanka, Indonesia and East Timor.

Dr. Haglund teaches medicolegal death investigation through the Washington State Criminal Justice Training Commission. He also conducts international workshops, seminars and training in international forensic investigations.

Dr. Haglund's numerous publications have addressed issues such as outdoor scene processing for human remains, taphonomy, and human identification. Among these are two books, *Taphonomy: the Postmortem Fate of Human Remains* and the *Medicolegal Death Investigator Training Manual*. He has been an affiliate member of the Board of Directors of the National Association of Medical Examiners, is a past, three-time president of the Washington State Coroner/Medical Examiner's Association, and is a fellow of the American Academy of Forensic Sciences.

Marcella Harnish Sorg, Ph.D., D.A.B.F.A., is the consulting forensic anthropologist for the states of Maine and New Hampshire and an associated faculty member of the Department of Anthropology, University of Maine, since 1977. She served at the University of Maine as Associate Director of the Center for the Study of the First Americans, Institute for Quaternary Studies, from 1983 to 1988, and in private business from 1988 to 1996. She is currently Research Associate at the Margaret Chase Smith Center for Public Policy and on the faculty of both the School of Nursing and Department of Anthropology.

Dr. Sorg received her R.N. from Fairview Park General Hospital in 1969, her B.A. in psychology from Bowling Green State University in 1972, and her Ph.D. in physical anthropology from The Ohio State University in 1979, and she was certified by the American Board of Forensic Anthropology in 1984. She has served as Secretary and as President of the American Board of Forensic Anthropology, and has returned recently to serve as a Director. Dr. Sorg is a Fellow of the American Academy of Forensic Sciences, a Member of the American Association of Physical Anthropologists, and the Maine Medico-Legal Society, and co-founder of the Northeast Forensic Anthropology Association.

Dr. Sorg has authored many publications in forensic anthropology, taphonomy, and genetic demography. She was co-editor of the book *Bone Modification* in 1987, of *Forensic Taphonomy* in 1997, and co-authored *The Cadaver Dog Handbook* in 2000. She has done forensic research on scavenger modification of human remains as well as on the timing of epiphyseal union in the female medial clavicle. Her current forensic research focuses on taphonomic approaches to remains exposed in both marine and terrestrial environments, the estimation of postmortem interval, and the use of cadaver dogs, particularly for scattered remains.

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Foreword

R. LEE LYMAN

Russian paleontologist I.A. Efremov (1940) coined the term *taphonomy* and defined it as the study of the transition, in all its details, of organic remains from the biosphere to the lithosphere. My dictionary defines *forensic* as pertaining to argument, debate, or public discussion suitable for courts of justice. Contributors to this volume and its precursor (Haglund and Sorg, 1997) would define *forensic taphonomy* as the study of the transition of humans from living organisms to mortal remains, including causes of death, for judicial or legal purposes. I find the extension of taphonomic research into forensics to be critical for one simple reason.

What can readily be categorized as taphonomic research has a deep history in paleontology, one of my two personal choices for the most exciting field of scientific inquiry, the other being archaeology. In the early nineteenth century, William Buckland (1823) observed how a hyena gnawed and thereby destroyed animal bones. Buckland used his observations to conclude that ancient bones with similar damage recovered from ancient cave deposits had been chewed by ancient hyenas. Archaeologist Edouard Lartet (1860) used precisely the same sort of reasoning to conclude that prehistoric humans had butchered extinct animals and, thus, humans and those beasts had been contemporaries. What Buckland, Lartet, and others in the nineteenth century were doing was *actualistic research* in an effort to gain insight to the processes that created particular taphonomic patterns among modern bones.

Actualistic research — documentation of modern processes and the visible effects and patterns they produce — formed the basis for their inferences that the same processes had created the patterns among both the modern and the prehistoric materials.

More than a century later, taphonomists have microscopes, including scanning electronic microscopes, instead of magnifying glasses, and they have computers to crunch all kinds of data of which Buckland and Lartet never dreamed. They also have radiocarbon dating laboratories to tell them exactly how old the bones are; biologists who can tell them the most intimate details about the physiology and life ways of the animals whose remains they are studying; chemists and geneticists to study dietary and genetic variation, respectively, as reflected in preserved tissues; and a host of other specialists, laboratories, and machines to help them decipher the fossil and subfossil records and thereby write taphonomic histories. Books and journal articles abound on each topic, indicating we know a great deal more about taphonomy than our intellectual predecessors of the nineteenth century. Yet the fundamental epistemology of actualism pioneered by Buckland, Lartet, and others remains the centerpiece of taphonomic and forensic research.

Taphonomy and forensics are identical fields of investigation. Both seek an answer to the question "What are these bones doing here?" as taphonomist Pat Shipman put it 20 years ago. True, forensic scientists want an answer they can take to court, whereas a taphonomist's answer is usually judged only by other taphonomists and perhaps a few paleontologists or zooarchaeologists. Otherwise, there is absolutely no reason why the methods and techniques of one field of inquiry cannot overlap virtually completely those of the other, and this brings us to the point of my brief history of taphonomy, the reason I find the extension of the definition of taphonomy to include forensics and human remains to be significant.

That point is simply this. Forensic scientists, on the one hand, are always looking for evidence that tells them what I think of as something positive about the bones and teeth they examine. Who was the represented individual? How and why did he or she die? Why are the mortal remains of the individual in the condition they are when found? Does anything about that condition imply a felonious act or help identify a perpetrator of the act? On the other hand, paleontologists and, particularly, zooarchaeologists are typically looking for what I think of as negative evidence, which I do not mean is the notion captured by the phrase "the absence of evidence is not necessarily evidence of absence," sometimes referred to with the shorthand "negative evidence." Rather, what I mean is that taphonomy is too often construed by taphonomists to merely comprise biasing processes.

Most of the time in the zooarchaeological literature of the 1980s and 1990s we find the phrase "strip away the taphonomy cover print" or some variant thereof (see Lyman [1994] for an introduction to the relevant literature). Much less frequently do we see the evidence a taphonomist examines construed as somehow contributing in a positive way to our understanding of and knowledge about the past. And that, I think, is an important lesson that taphonomists can learn from forensic scientists. What do those gnawing marks apparently generated by carnivores represent with respect to the paleoecological setting in which the bones were deposited? Certainly more than that some bones or bone parts might be missing not because ancient hominids didn't deposit them in the site sediments but because carnivores removed them. Those gnawing marks clearly mean that carnivores were part of the paleoecological setting, just as butchering marks on other bones in the collection signify that hominids were another part of the setting, had tools, and were extracting resources from animal carcasses; this was Lartet's inference of 1860 and that same inference can be made today.

Perhaps I am a bit too pessimistic with respect to my taphonomically inclined colleagues. Regardless of that, I think it is clear that we need to think about taphonomic histories in the same way that forensic scientists think about the human remains that they study — as revealing aspects of those histories that could be important for both analysis and interpretation. But by the same token, forensic scientists need to think, at least sometimes, like taphonomists; that is, to think of the negative aspects of taphonomic histories, the possible biases. For example, they need to be able to distinguish damage to bones that resulted from rodent gnawing from damage that resulted from felonious assault on the individual. They also must recognize that the former, if sufficiently extensive, may well remove all traces of the latter; that is, taphonomic history can bias — be negative — forensic evidence.

I have argued that taphonomy and forensic science are, in a very practical way, sister disciplines. But they are also a bit different and some of us occasionally forget that fact. That these disciplines are different can be made clear by posing a question and telling a brief story to answer. Why are human feet sometimes so much better preserved than other parts of the body? A taphonomist would argue that it may be the result of the greater structural density of foot bones than other bones of the human skeleton. But as my colleague Sam Stout, who oversees the Human Skeletal Identification Laboratory at the University of Missouri, Columbia, pointed out to me, humans wear shoes, and footwear protects and shields human feet from the ravages of various sorts of taphonomic agents. On one occasion, Stout was out of town and two deputy sheriffs seeking his counsel showed up at my office near the forensic lab. They handed me a tightly sealed plastic bag and asked that I make sure that Dr. Stout be given the bag as its contents comprised important forensic evidence for a legal case.

I glanced at the bag and asked the deputies why Stout would want the wing tip shoe the bag contained. The deputies replied, "Because of the foot inside the shoe." Stout was glad to have such a complete portion of the human anatomy; I nearly lost my lunch. Looking back at that example, I *did* learn something from the forensic perspective. Forensic scientists can no doubt learn similar lessons from taphonomists, and probably without any feeling of nausea.

The chapters in this volume are important contributions. In my view they reveal many of the parallels between taphonomy and forensic science, and in many ways other than the most fundamental shared aspect — actualism. Those of us in the taphonomy business can learn much about the earliest stages of taphonomic histories by reading this book. Forensic scientists can learn an equal amount by close study of the research undertaken by taphonomists that is described here. There is no shortage of paleontologically and archaeologically related studies focusing on single and multiple body or carcass sets of remains. Taphonomists often perform various types of actualistic research that forensic scientists would no doubt find of some utility were they to examine it. Recently, I've heard more and more regarding the benefits of interdisciplinary research — more funding, more solidly founded results, more relevant and pertinent conclusions, more marketable graduate students with interdisciplinary training. Forensic scientists and taphonomists would be well advised to pay heed and to interact much more frequently. This book is an important step in that direction.

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Foreword

DONALD T. REAY

This second volume on forensic taphonomy adds to the available information about the postmortem fate of human remains. It is necessary to review the objectives first laid out by the editors in their first volume, *Forensic Taphonomy: the Postmortem Fate of Human Remains* (1997). In its introduction, the editors stated, "Data can be collected routinely in the normal course of the forensic investigation without interfering with the medical legal process. And if data collection strategies are shared among practitioners, the data sets will be more comparable and broader-based." In their first volume, the editors made a major contribution to our understanding of how bodies decompose in different environmental conditions, the effects on the body of human and non-human activities including animal scavenging, the effects of aqueous dispersion of bodies and body parts, and the effects of immediate postmortem transfer. Although the first volume is multi-authored, each chapter provides the reader with new data and observations, frequently about individual cases, but nicely synthesized and discussed for the reader to ponder their significance. This second volume brings new data and observations extending from the initial volume, and again gives us insight into the discipline of forensic taphonomy.

I would be remiss not to comment on what I consider the major achievement that the editors have attained by publishing on this subject. In 1991, I had the distinct privilege of reviewing the doctoral thesis of Dr. Haglund (Haglund, 1991). This was my first exposure to an organized body of information which dealt with the subject of taphonomy. Much of this work was the result of some 10 years of investigation into the deaths of a number of women who were the composite of the Green River murder investigation. During that investigation the bodies of young women were discovered in varying states of decomposition including skeletonization. At that time, our emphasis was on establishing identity and cause of death, the typical obligation and expectation of any agency responsible for examining human remains in a death investigation. Through the efforts of Dr. Haglund other information began to emerge. The manner and sequence of the disarticulation of the skeleton were noted and the way in which bodies were scavenged by predators was observed. Additionally, the environmental milieu in which human remains were found took on new significance. Although the ambient conditions have always been recognized as playing a major role in establishing time of death, as it unfolds and manifests itself in decomposition, assessing these observations for answers took on considerable urgency because of the nature of this serial murder investigation.

In attempting to answer some questions concerning the nature of the decomposition and the dispersal of skeletal remains by predators, standard references in anthropology and forensic pathology were consulted. Sources from both these fields were found wanting in providing specific useful information. It was clear that anthropology and forensic pathology had not progressed to the point where useful information and observations had been recorded to aid our investigation. It was also clear that archeologists and paleontologists had much to say regarding the handling and processing of a scene where ancient human remains had been discovered.

Recognizing the limitations of the information that was available, we attempted to answer questions about the postmortem fate of human remains during our death investigation. This was a new and exciting area of exploration which stimulated Dr. Haglund to organize the observations that later formed the central theme of his doctoral thesis. In my view, a new discipline of forensic taphonomy emerged for use by the forensic community.

Why "taphonomy?" The use of the word has been generally restricted to the archeological recovery of burial sites and, to some authors (Olsen, 1980), the study of dead organisms from the biosphere to the lithosphere, i.e., fossilized organisms and their death assemblages. Taphonomy comes from the Greek *taphe*, which means grave. Since it has an archeological meaning for the study of gravesites, the subject material under examination from a forensic point of view is the study of the site of discovery of a body, which can be a shallow or deep grave or a surface deposit. The immediate concerns of the death investigator are the disintegration of flesh and bone in different environmental conditions and how it relates to the time of death. Other concerns include the modifications and disbursement of body parts caused by animal scavengers and the effects of standing and running water on a body; and the effects on a body of postmortem trauma whether inflicted by another human, animal, or the environment.

It is fitting to make available whatever information exists on the subject of forensic taphonomy to enhance any death investigation where a body has been exposed to a variety of forces of man and nature. Volume 1 succeeded in accomplishing its goal of presenting data and information from a variety of sources in a very readable and scholarly fashion. This second volume amplifies the success of the first. The editors are to be commended for assembling the contributors to present information for use by the forensic community.

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Foreword: A Pilgrim in Forensic Archaeology — A Personal View

J.R. HUNTER

Forensic archaeology is a relatively well-recognized area of study in the United States where it is a component of physical anthropology in medico-legal matters. However, in the United Kingdom, where archaeology evolved as an independent discipline concerned purely with excavation and field skills, and in which human skeletal analysis was incidental rather than focal, forensic archaeology developed somewhat later and with a different character. Differences between the two "archaeologies" become compounded at scenes of crime: in Britain, for example, post-mortem study is normally the legal responsibility of the forensic pathologist, the role of the forensic archaeologist being one of providing supporting data through fieldwork.

Forensic archaeology probably took its first public bow on a U.K. stage in 1988 with the discovery and excavation of a 3-year-old boy called Stephen Jennings, murdered by his father some 26 years earlier. There may have been instances of archaeologists assisting in other cases before then, but there are no informal, or even folk records of such, nor are there any more formal reports of archaeologists being called upon to give evidence in court. For this archaeologist, one of those involved in the recovery of Stephen Jennings, the event set in motion an unwitting divergence from an otherwise innocent career in historical archaeology.

Since that time the smooth and predictable cycle of academic life has been disrupted by visits to distant parts of the country at short notice, by lengthy briefing meetings about hitherto unknown nefarious individuals and their activities, and by unpredictable late night telephone calls. The number of homicide cases involved over the years has never been counted; some merely reared their heads as requests for advice, or as visits by officers bearing a bag of bones, but every year a consistent number developed into scene visits and into deeper, practical involvement. These have occurred as complete burials, dismemberments and cremations; they have involved adults, children, ex-lovers, and spouses, and prostitutes; they have been brought about by drugs, accident, cultural incompatibility, or by sheer hatred; and the victims have been buried deeply, shallowly, or simply dumped on the surface and concealed. Taphonomically, some have decayed beyond recognition, some show differential decay, some still hung together articulately thanks to the resilience of synthetic fibers, and others had been scavenged by creatures of the wild. No two cases have ever been the same, or even remotely similar. They testify to unpleasant sub-cultures normally concealed from the gaze of much of society, and are viewed uncomfortably by many middle-class undergraduates who wrongly considered forensic archaeology to be a more glamorous subject for study.

Forensic archaeology has evolved rather than flourished, and this somewhat personal view touches upon, inter alia, matters of professional and ethical responsibility encountered by its practitioners working in a novel arena. Conveniently, it follows an earlier paper that sought to market forensic archaeology to an unwary U.K. archaeological community (Hunter 1994).

Background

There used to be the naive view, certainly held by this practitioner, that to trot across a suspect's garden with a twin-probe geophysics array would undoubtedly detect the buried remains of some unfaithful spouse allegedly buried there and, equally, that to apply skilled archaeological methodology at a scene of crime was all that was necessary to ensure recovery in the best professional way. Such simplicity was soon dashed. It became manifestly apparent that forensic archaeology would never be a straightforward transference of methodology, but rather the application of archaeological theory to forensic circumstance. The time frame, the protocols, the processes, the chains of evidence, the working parameters, the ancillary disciplines, and the judicial constraints were all distinctive. More pertinently, the way in which the buried data were interrogated was different, and this alone effectively created a divergence between forensic archaeology and research-driven archaeology.

In a recent paper entitled "The Excavation of Modern Murder" there was an attempt to flag some of the questioning that guided the excavation of a homicide victim; it also highlighted the differences between those questions and those designs which underlie the research-driven excavation of, for example, a Romano-British burial (Hunter, 1999). Pathological examination of a murder victim normally requires responses on at least three fronts: identity, interval since death, and cause/manner of death. Archaeological intervention can, directly or indirectly, aid all three, but the questions are already diverging from those normally asked under typical archaeological circumstances. Most significant is the issue of individuality: the homicide remains become personalized, they have a name, and they may have a grieving family. The life, activities, and last movement of the victim become a focus of necessary interest, and thus the ethical issues and professional responsibilities take on a different character from those of the traditional archaeological norm.

Ultimately the forensic inquiry is geared to resolving the question, "Who killed this person?" In helping to achieve that answer the forensic archaeologist asks questions not normally voiced under purely archaeological conditions, and these questions frame the methodology of inquiry accordingly. Recovery is not simply the recording of buried evidence. It involves an understanding of how a grave might have been dug, the transfer of material between offender and grave, the nature of that material, how it can be sampled, how it can be contaminated, and often the degree of conclusiveness it can offer as evidence within the strict definitions imposed by forensic science.

The archaeologist not only needs to be sure of his or her role within the investigating team, but must also be confident about how other members of the team operate, the nature of their evidence, and their respective methodologies. Other team members — the forensic scientist, entomologist, pathologist, and scene of crime examiners, etc. — have different evidentiary requirements based on diverse knowledge, background, and training. There are also new areas of study, including taphonomy, which lie in no-man's land. Taphonomy covers more than simple decay process. Often perceived incorrectly as the exclusive remit of the forensic pathologist, it requires a diversity of knowledge from animal behavior and bacteriological activity to climatic and botanical effects (see Haglund and Sorg, 1997).

Mission and Morality

Forensic archaeology requires team playing within a broad panorama of the different groups and disciplines involved. The archaeologist needs not only to understand the respective roles, but also to ensure that the different groups understand the nature of archaeological inquiry. Sigler Eisenberg's early (1985) identification of a mission factor was especially perspicacious in this respect, but mission also seems equally relevant within the archaeological community itself. In a well-worded article, Cox (1998) criticized a number of operators for calling themselves forensic archaeologists when they were unlikely to appreciate the nature of criminal inquiry, the archaeologist's role within it, or the extent of subject areas involved from psychology to taphonomy. There are also, sadly, archaeological purists who have failed to grasp what forensic archaeology is really about simply because they have been unable to recognize that the questioning of the buried data and the goals are distinctive from traditional archaeology.

The end point of the forensic process is the conviction of the offender. In the recovery and autopsy of the victim, there is a strong argument to suggest that the end justifies whatever means are necessary to achieve it. In human terms, the recovered buried remains possess a name, a history, and a set of familial relationships. In cold, clinical, terms, they constitute potential evidence that requires investigation, analysis, or dissection to answer specific questions. It may be that the need to achieve those answers requires the dominance of one technique over another, that the need to collect one type of evidence overrules the loss of other evidence. Decisions are made through collaboration between scene specialists, not through a process of ethical and moral dilemmas, nor through the exactitudes of archaeological purism. What matters most are the underlying principles of the various techniques involved and the ability of all concerned to understand them. This is a process in which the archaeologist has to respond to a given situation: what may be professional best practice in one archaeological context is not necessarily best practice in a forensic one, and vice versa.

It is perhaps opportune that the levels of competence and ability required in a forensic archaeologist are now being defined more precisely. The U.K. is moving inexorably toward the registration of forensic practitioners in all fields, from archaeologists to entomologists and from fingerprint specialists to toxicologists. Experience suggests that key requirements for a forensic archaeologist will be a long and varied experience in archaeological fieldwork, a working knowledge of skeletal remains, and the ability to operate independently within a crime scene, to make rapid decisions, and to be confident. Over-arching, however, is the need to understand crime scene protocols and the evidentiary requirements of others involved at the scene itself.

The fragmented police structure in Britain means that disseminating information of any type or spreading mission is extremely difficult. The evidence from the relatively low number of burials in the U.K. each year (there is no precise figure but information suggests probably less than around 15 per year out of a total of some 700 homicides), based on word of mouth and anecdote, suggests that around half of these utilize proper archaeological techniques. Most involve instances where the burial site is known, the operation is fully briefed, and the forensic archaeologist is brought in at an early stage. The others (again, based on word of mouth and anecdote) are dug up rapidly without archaeological support through the necessity for speed (custody law in Scotland, for example, is only 6 hours), because they were found in an existing operation, or because of the perceived costs of bringing in specialists when the case is already cut and dried (i.e., when the necessary questions had already been answered without specialist support).

Some police forces are more than happy to use archaeologists, and draw them in frequently at the earliest opportunity, whereas others are clearly not interested. Ignorance is no longer an excuse: several archaeologists have expended much energy and effort over the last decade in presentations on search and recovery to various groups involved, e.g., detectives, scene of crime officers, forensic scientists, coroners, etc. Homicide convictions have used archaeological evidence, and hence exhumation without archaeological assistance now lays itself open to more exacting cross-examination in court. One recent case was based entirely on taphonomic criteria. Was the victim's state of decay commensurate with the interval since death and with active local carnivore activity, or had the body been moved? And who is competent to give opinion? To what extent is this "archaeology" by either U.K. or U.S. definitions?

In retrospect, some 12 years since Stephen Jennings was excavated by archaeologists, there has been substantial progress, but not wholesale practical acceptance by either police forces or even archaeologists themselves. Stephen Jennings was a landmark. Whatever brutality and abuse he suffered in his 3.5 years of life are in some small way balanced by a growing string of life sentences that have occurred since, for which the recovery of his body was an archaeological precedent. However, even after these same 12 years, those few archaeologists who practiced forensic archaeology on their own time then, as some form of conviction, are still doing it today, still on their own time as an extra to their "day" jobs. More significant progress might perhaps have been made from a single high-profile case with national media interest.

Breadth

At a conference in 1995 I made the throwaway comment that forensic investigation was one of the most frightening exercises for an archaeologist to undertake (see Cox, 1995). It was, however, a comment restricted to an experience of the occasional scene of crime, of helping to resolve some clandestine event by pitting wits against an unknown adversary. The rewards lie in achieving a sense of altruism from applying skills to society's darker side, while being protected from the full reality by a cushion of scene protocols and a buffer of judicial machinery. These mixed sensations will be familiar to those who have undertaken the same or something similar, but the experience did not embrace the horrors of genocide and mass graves, where the motivation of inquiry and the questioning of evidence differ even further from research-led archaeology. Nor was it anticipated that Mant's early work on taphonomic processes might be called upon to explain or predict the state of decay in multiple burials (see Mant, 1987). Those archaeologists who have gone to the killing fields of Rwanda, Bosnia, or Kosovo will be more acutely aware of these various issues as well as the emotional factors involved.

The word "forensic" is not to be taken lightly. Unlike other specialist archaeological epithets — "environmental," "underwater," or "Aegean" — it involves a gravitas and a more distinctive knowledge base than is generally recognized by many other archaeologists. Like its research parent, forensic archaeology has no well-defined limits: it branches into fairly obvious areas such as biological anthropology; and it covers other taphonomic phenomena, although both the timescales and the materials are novel (cardboard, paper, cigarette butts, plastics and synthetic fibers, and human decay in the short term). Forensic archaeology also feeds off other intelligences of which the pure archaeologist might be better aware, notably offender profiling and dump site analysis. It also merges, uncomfortably, into matters of human rights.

Until about 5 years ago, the concept of human rights had no place in the emerging forensic archaeology of Europe, or even in its vocabulary. From the United States physical anthropologists spread their expertise into South and Central America, and then into Africa, initially to recover and assess the mass graves of victims of genocide and political killings, and subsequently to recognize evidence of torture and human rights violations on human remains. Belief that such atrocity could never occur within the civilized western world was overly optimistic. Bosnia put an end to that, as later did Kosovo.

Pessimism suggests that it is in human nature for there to be more killings, and that there is some urgency to improve on our expertise for the next time. Forensic archaeology's first 12 years in the U.K., if nothing else, have been a learning curve; no two scenes of crime, big or small are ever the same and the emergence of human rights issues has become a fact of life in forensic archaeology whether we like it or not. Torture, for example, both psychological and physical, can occur in many ways: beatings, suspension, electric shock, burns, asphyxiation, nail torture, dental torture, pressure, strapping, forced positions, sexual abuse, etc., and any of these can leave traces on the hard as well as the soft tissue (Henneberg, 1999). It is important that the archaeologist knows about them during the recovery process, and that the anthropologist knows what to look for in the autopsy. Once again it is the nature of the questions that drives the method of recovery, not the direct application of field archaeology.

The excavation of mass graves in Bosnia and Kosovo has also provided a much needed focus for the energies and convictions of forensic archaeologists and forensic anthropologists from many parts of Europe, notably Scandinavia and the United Kingdom. This is understandable given that the skills and knowledge these people learn (many of them students) from a growing range of university courses are largely unpracticed in what we might call normal criminal circumstances, and are likely to remain so. For some this is probably the only way of getting forensic archaeology experience.

Archaeologists tend to be noted for the values they hold, their concern for the environment, and for their contribution to society's knowledge base. To many archaeologists, working within mass graves is to exercise archaeological skills in an unusually meaningful way, and one more suited to satisfying personal missions under the disguise of altruism. It fits well, too, with a profession based on short-term employment contracts, and which in the United Kingdom at least has seen the prescriptive processing of developer-led archaeology sap much of the creative spirit from the discipline. Bosnia also gives some scope for physical anthropologists to practice in a real scenario, not just with the bones from an Iron Age cemetery and the odd Romano-British family. This is particularly relevant for those practitioners from countries where, unlike the United States, physical anthropologists have no traditional role in the forensic process. These may be some of the reasons why Bosnia and Kosovo seem so attractive.

Forensic archaeology can also act as a postbox to a rich variety of skills that may be used on an occasional basis — zoological and botanical reference sets, total station recording or conservation skills, palynology, soils science etc. — all of which supplement the existing bread-and-butter techniques of the established forensic science service. This is a new and largely untapped forensic science resource. Sadly, it can become embarrassing when the archaeological proponents of these skills profess minimal or nil interest in support. They are reluctant to drop everything at a few hours' notice, to be distracted, or be inconvenienced after hours. While quite content to bask in the heat of being an expert in beetles, grasses, teeth, cremations, or snails, they are not prepared to be inconvenienced where their contribution might matter most.

Forensic archaeology feeds off other intelligences of which the traditional archaeologist might be aware, notably offender profiling, site disposal statistics, witness veracity, etc. All these have to be slotted into an equation in a forensic search before site targeting can take place. Not only does the archaeologist begin to know the victim, but there is also a real need to know about the offender, because knowing about the offender helps to locate the grave. How can objectivity possibly be retained under such circumstances? How is it possible to balance the need to remain clinical, and at a mental distance? And what happens when, despite all efforts to prevent it, there is involvement with the family of a victim, a victim who has not been found, and whose case the police may have wound down? Is it still possible to remain detached from the event? The longer and more detailed the case, the more familiar the victim becomes to the searcher. There are some victims I have never met, but I know them better than I know some of my friends. Where do ethics and responsibility fit into that context, and is it something that should now be reflected in our archaeology degree programs?

Search

Recovery is only one part of the forensic archaeological spectrum. Another important aspect, and probably the one used most frequently is search. Several archaeologists, working independently for any of the 40 or so separate police forces which constitute the United Kingdom's law enforcement system, noticed the lack of awareness among police forces regarding the range of search techniques available (technical, human, and canine) for finding clandestine graves. They also noted that the advantages and limitations of the respective techniques were largely unrecognized, and the extent to which the decay processes of the individual were being ignored in the detection equation. There was little conception, for example, of using complementary methods, or even sequences, depending on the situation. There was, by contrast, a tendency for police forces to use ground-penetrating radar (GPR) irrespective of whether it would work within the environment in question, its cost, and whether the operator was familiar with the responses given by GRP to human remains as opposed to the more customary civil engineering application. There was a similar tendency to consider geological search techniques with little in the way of regard for the scale of the task in hand, the nature of the local environment, or of the required sensitivity of response.

The clear need for a central advice forum was eventually satisfied by the setting up in 1996 of the Forensic Search Advisory Group (FSAG) which incorporated personnel in academic life, commerce, police, and the military, covering a range of skills including geophysics, aerial interpretation, archaeology, decay chemistry, and body-scent dog training. Although the group has no formal status, it enjoys the recognition of ACPO (Association of Chief Police Officers) and is used frequently by the Home Office and the National Crime

Faculty to put any police force requiring support in touch with the group by means of a 24-hour pager system. The group receives requests approximately 30 times per year on average, of which about two thirds result in operational support. The FSAG is broadly modeled on NecroSearch International, a similar but larger group in the United States. Elsewhere in Europe a similar organization has emerged in Sweden and a new group is forming in The Netherlands. There are embryonic noises emanating from other countries, but in general there is little awareness elsewhere of the opportunities and potential available from harnessing and centralizing resources in this way.

Experience of this centralized search facility suggests that search usually follows one of two broadly defined routes (although there are always exceptions): (1) cases where a person is missing and a homicide and disposal are thought to have occurred, and where a number of locations need identifying and targeting; and (2) instances where information is received that an alleged clandestine burial has occurred in a particular vicinity, usually in a place that can be closely defined.

The first of these involves a protracted analysis, initially desktop, of landscape, geology, and photographic evidence, together with psychological profiling, dump analysis, and the use of other intelligence. This includes targeting possible locations and utilizing certain techniques and sequences of techniques in order to maximize recovery potential. In these investigations the body of a known victim is being actively pursued. The second, and undoubtedly the more common, requires the elimination of sites. The information that promotes them is often hearsay, nostalgic, and warped through passage of time and drug or alcohol abuse. Despite this, the information often seems to contain some elements of truth and has to be verified, but in these investigations the onus is on eliminating the site from a potential inquiry and the methodology differs accordingly. These two broad types constitute the majority of scenarios. It could be argued that the methods for determining that a burial is not there are not necessarily the same as those implemented for proving that it is there.

The importance of the archaeological pedigree in forensic search, and in forensic geophysics in particular, is simply that the requirements of archaeology bear much closer resemblance to those of operational taphonomic phenomena, etc. Many of us would also like to see a situation in which some practitioners are able to operate in a manner that is more than a hurried addition to their own livelihoods and careers. Highest on the list, however, is the need to fund, coordinate and develop the discipline to a level of more universal respectability, not just in the United Kingdom but also throughout Europe. Forensic archaeology, a victim of structure and perception, still has a long, long way to go.

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Section 1

Theoretical Perspectives

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Advancing Forensic Taphonomy: Purpose, Theory, and Process

1

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Background

Since work began on the first volume *Forensic Taphonomy* in 1993 (Haglund and Sorg, 1997a), traditional taphonomy and forensic research has undergone significant change. Additionally, despite the wide range of topics covered in the first volume, there remained significant topics not covered and those that should be covered in more depth. This volume attempts to extend coverage to include recent advances in the allied taphonomic and forensic fields as well as to explore a number of topics more fully or from a different perspective. The continuing effort is to articulate the interface among the paleontological, archaeological, and forensic sciences, placing it under one interdisciplinary umbrella (Haglund, 1991; Haglund and Sorg, 1997b,c).

In many ways forensic taphonomy contrasts with and complements paleotaphonomy. Martin (1999) describes the purview of paleotaphonomy as an environmental and historical science, along with paleontology and geology. He argues that it is this very long timescale that is uniquely valuable in terms of its suitability for studying global environmental problems. With this long, time-averaged view, "The surface mixed layer or taphonomically active zone (TAZ) of sediment acts as a low pass filter, primarily through bioturbation and dissolution, that dumps high frequency signals before their incorporation into the historical record… (and) short-term noise is damped" (Martin, 1999b:vii). In fact, forensic taphonomy has just the opposite focus on the recent time frame (including the TAZ so contaminated by bioturbation) and particularly upon the anthropogenic 'noise' that Martin would seek to silence.

In our own evaluation of the first volume, we felt that, although we had brought many disparate topics together and had focused a taphonomic perspective on forensic work, there were shortcomings that we continue to face. The relevance of forensic case material and research to paleontology and archaeology needs to be demonstrated. More effort needs to be given to a systematic approach to forensic recovery and interpretation which incorporates archaeological methods, and some attention needs to be focused on understanding (and precisely describing) the early decomposition process and its consequences for diagenesis and paleontological or archaeological interpretation. In this volume, we have chosen an explicitly bioenvironmental and idioecological approach. By bioenvironmental, we mean the incorporation of biological and environmental data using interpretive frameworks, models, and theory from allied disciplines. By idioecological, we mean the explicit focus on the idiosyncratic synchronic and diachronic (so-called context-specific) features of the case microenvironment, including the ecology and the particular historic sequence of taphonomic events. This is not new within archaeology and paleontology (Donovan, 1991; Gifford-Gonzolez, 1981; Haynes, 1980; Klein and Cruz-Uribe, 1984; Lyman, 1994; Martin, 1999a; Morse et al., 1983; Schafer, 1972; Shipman, 1981; Voorhies, 1969). But forensic efforts suffer from either too narrow disciplinary efforts or, conversely, models that are too general to offer much explanatory value for forensic practice. There is much progress to be made along these lines; this is only a beginning.

The practice of forensic taphonomy is often an international endeavor. Although our closest connections have been with the Canada and the United Kingdom, recent work with mass fatalities, mass graves, and human rights offenses has involved problems worldwide with international teams of pathologists, archaeologists, and physical anthropologists (Haglund et al., 2001; Scott, 2001; Stover and Ryan, 2001). In fact, anthropologists have had to come to terms with human rights issues that rise to a level that dwarfs cultural relativism (An-Naím, 1992; Cohen, 1989; Fluehr-Lobban, 1995; Messer, 1993; Washburn, 1987). It is our purpose to increase visibility and understanding of the emerging issues, not only in terms of taphonomy and site interpretation, but also of variations across cultures and nations in how forensic taphonomy is practiced and how professionals are qualified (see, for example, Steyn and Meiring, 1997). To that end we have devoted a major section of the book to these topics.

Conceptual Framework of Forensic Taphonomy

The Unit of Analysis

From both taphonomic and ecological perspectives, the carcass can be considered the centerpiece of a newly emerging microenvironment (Kormondy and Brown, 1998; Krebs, 1994). It provides a serendipitous food source, setting off a complex set of trophic phases of consumption, decomposition, assimilation, and dispersal (Haglund, 1988a; Haynes, 1982; Hill, 1979; Mann et al., 1990). It also initiates particular changes in the chemistry and temperature of the immediate surroundings (Coe, 1978). Many of these changes are themselves catalytic, initiating or facilitating further processes.

These processes are dependent on whatever unique patterns or sequences characterized the environment prior to deposition of the body: local features of the biosphere, lithosphere, and atmosphere (Behrensmeyer and Hill, 1980; Lyman, 1994). These factors continually interact and impact whatever taphonomic activity is occurring, having a differential effect depending on their own cycles of variation (e.g., ecological community, geological processes, weather/season), the interplay of those cycles, and the phases of decomposition of the index set of remains.

As time passes and the body decomposes (in many outdoor settings), body and context tend to merge. The boundaries of the body diverge as decomposing materials penetrate the ground, are carried away by moving water, are digested by insect, mammalian, crustacean, or fish scavengers, or are volatilized to the air or water. Likewise, the environment penetrates the body as minerals from groundwater or sediment are incorporated into bone, plant roots and soil microbes penetrate soft tissue and bone, and sediment accumulates to surround and potentially bury the body.

The particular decomposing human body becomes our unit of analysis at some point in its postmortem processes (Table 1.1). This is an extremely arbitrary aspect of taphonomic analysis, i.e., that this particular decomposing organism should be singled out for our analytical attention from the myriad other organisms whose remains are currently present and also decomposing at a given location. This bias persists as we select pertinent models for understanding the index organism. The shorter postmortem timeframe of a forensic taphonomy investigation (compared with traditional paleotaphonomy) dictates that particular attention be paid to data accumulating from periodic changes (e.g., seasonal, diurnal) with a cycle wavelength shorter than the postmortem interval (Martin, 1999); these data constitute the relevant diachronic context. All other data can be grouped as the background, the synchronic context, for the purpose of a particular analysis.

Diachronic context data about other currently operating biotic process in the microenvironment, i.e., processes with a relevant periodicity (e.g., necrophagous insect succession associated with the body under consideration) provide useable taphonomic data. But diachronic data at the macroenvironmental level, such as faunal extinctions, probably

Table 1.1 Environmental Frameworks and Relevant Contexts

Macroenvironment [Synchronic Context]	Macroenvironment Periodicity, within the Postmortem Interval [Diachronic Context]	Microenvironment, Site Specific, at the Point of Recovery (Actual) or Point of Death (Reconstructed) [Synchronic Context]	Microenvironment Periodicity, Site Specific, within the Postmortem Interval [Diachronic Context]
Atmosphere	• Point within long-term climate change cycles	• Current temperature • Current precipitation • Current distribution of water • Oxygenation	• Accumulated degree days • Precipitation pattern
Lithosphere	• Point within long-term geological change, such as continental drift, rising sea levels	• Surface relief, terrain • Minerals present • Salinity • Alkalinity • Water vs. land distribution • Soil type	• Recent changes in landscape • Seasonal changes in landscape at that location
Biosphere	• Point within long-term faunal and floral changes, extinctions	• Producer, consumer, and decomposer presence • Primary productivity • Scavenger home ranges and territories	• Seasonal changes in plant and animal presence, activity • Necrophagous insect succession • Necrotic bacteria and fungal succession • Nitrogen cycle associated with remains

would not. Thus, the necessary interdisciplinary mix, the relevant biological models, and the data collection methods will differ somewhat between paleo- and forensic taphonomy, and will depend on the problem to be solved and the postmortem interval involved. Taphonomic data may provide clues to an ancient environment or may be extraneous or artifactual to the temporal or topical research focus (see Lyman Foreword, this volume).

Nevertheless, as the body makes its way from the biosphere to the lithosphere, both earlier and later diachronic data are potentially relevant no matter whether the postmortem interval is centuries or days. The consequences of local scavenger activity, for example, or deposition during a dry spell, or flash flood, while the remains are still articulated, or while the skeleton is still fresh, or some other set of variables, will theoretically affect any subsequent analysis.

The time during which soft tissue persists is a critical period taphonomically. The probability is enhanced for a wide range of dramatic alterations prior to decomposition, consumption, or preservation by, e.g., mummification, freezing, or adipocere formation (Haglund and Sorg, 1997a; Micozzi, 1991). The speed and attendant consequences of the taphonomic processes are great during this early period.

From a forensic point of view, correct interpretation of the events surrounding a death is dependent on knowing both the sequence and character of the taphonomic processes.

Taphonomic artifact may need to be stripped away to reveal forensic information, e.g., to discriminate scavenger modification from perimortem trauma. Conversely, taphonomic data may itself constitute forensic evidence, e.g., of the original place of death and transport, the behavior of the perpetrator (humans may be taphonomic agents), or the postmortem interval (cf. Lyman, 1994; Foreword this volume).

No longer is skeletal morphology the only primary data derived directly from the skeleton itself. DNA extraction and analysis have rapidly risen to assume a partnership role, even when remains are decomposed or skeletonized. Harvey and King (Chapter 24, this volume) provide an update on DNA techniques along with a number of case examples. The body's interface with its surroundings is not entirely discrete; it does not stop at the skeleton or the skin. Cells are lost constantly to the environment; some sources estimate thousands of dead or dying skin cells are lost each minute by a living individual. As our technical capacity increases, these tiny data sources will increase as well. Olfactory cues are used in forensic work (Hunt, 1999; Rebmann et al., 2000; Sorg et al., 1998) and may be a future potential source of taphonomic data. It is known that olfactory cues attract scavengers, including insects (see Hall, 1995); thus olfaction is an important aspect of scavenger patterning. As more is learned about decomposition, chemical signatures (Voss et al., 1992) and bacterial signatures (Pfeiffer et al., 1998) may become more important.

Taphonomic Time and Context

From the point of view of the forensic investigator, there are at least three events in taphonomic time: (1) the time of death; (2) the time of deposition in the recovery location; and (3) the time of recovery. But usually these events are not chronologically precise or even discoverable as actual points in time. Viewed in a more processual way, the taphonomic reconstruction is concerned with the ecological, biological, and physical context and processes impacting a particular set of remains during four temporal contexts: (1) the antemortem taphonomic period just prior to death and/or deposition; (2) the perimortem taphonomic period around the time of death and deposition; (3) the postmortem taphonomic period from deposition to recovery; and (4) the postrecovery taphonomic period from recovery to analysis. In some cases, there is also an archival period following analysis. Additionally, there may be a multiple, sequential taphonomic contexts due to transport or sequential modification agents.

We have added the qualifier taphonomic to the temporal context designations for several reasons. First, the taphonomic perspective differs, although not completely, from the traditional medical usage, which generally focuses on fleshed remains with a rather short postmortem interval and on chronological reconstructions. *Taphonomic time* is a form of the archaeological concept *relative time* as opposed to time expressed in hours, days, and years, i.e., *chronological time*. It may be expressed as a function of the condition of the remains, for example, a stage of decomposition or stage of disarticulation.

In medical parlance antemortem (*sensu stricto*, before death) can refer to the entirety of an individual's biological and medical history prior to the relatively precise moment of brain death (see also Symes et al., Chapter 21, this volume), although it is usually used more narrowly. Perimortem generally refers to a fairly narrow time interval encompassing the death event. By contrast, the antemortem taphonomic period is characterized by the condition of the organism just prior to death (location, position, covering, size, shape, stage of development, presence of non-fatal wounding), inferred from or based on characteristics that can be discovered at recovery or analysis. The perimortem taphonomic period is not an actual time period, but a designation that infers the investigator's inability to discriminate ante- and postmortem modifications, i.e., the remains have characteristics of being antemortem, but could possibly also be early postmortem. These determinations cannot be based on vital/non-vital reactions but rather must be based on biochemical and/or biomechanical conditions that are only indirectly related to the passage of time.

Thus, to the extent that remains are decomposed, fragmented, or skeletonized, taphonomic time designations (of wounding, for example) usually cannot be precise *à propos* the medically defined moment of death. By way of illustration, impacts upon living or freshly postmortem long bone shafts tend to create defects that are curvilinear or spiraled, so long as the bone tissue retains sufficient fat and moisture; these are related to the taphonomic perimortem period. Such fractures might have happened while the person was living, but died before healing took place, or they might have happened after death, while the bone was still behaving biomechanically as if it were fresh. The same impacts applied to more decomposed or dried bone tissue tend to be more rectilinear, may be frayed, or may expose unstained fracture margins; these occur in the taphonomic postmortem period.

Similarly, concepts and terms of taphonomic time may be applied to the scene or deposition site. This is conceptually useful in understanding and reconstructing the microenvironment that comes to house the remains, and in differentiating agents of modification. Predepositional period refers to the nature of the microenvironment just prior to deposition of the remains. Depositional period refers to the time in which alterations in the microenvironment were connected with the depositional event. Postdepositional period comprises the time after deposition and before recovery and refers to the characteristics and changes in the microenvironment due to the presence of the remains. Recovery period is the time during which the remains identifiable as such are removed from the context. Postrecovery period is the time following removal of the remains and refers to changes in the microenvironment due to removal of the remains.

Table 1.1 outlines these taphonomic periods with respect to the data sets and analytical foci potentially involved in handling a forensic case. The efforts itemized in individual cells may, however, be combined, abbreviated, or eliminated altogether depending on unique aspects of the case, budget, and time constraints. For conceptual clarity, a generic and simple forensic model is used to create Table 1.2: a homicide at one location and transported to a single outdoor deposition site where the remains are deposited and ultimately recovered. It assumes that both the death and the deposition at the place recovered occur in the perimortem time frame; obviously, this is not always so. Additionally, it assumes that recovery is done at the place of deposition; in reality, remains are sometimes moved more than once in the postmortem period.

A Brief History of Taphonomic Data Collection in Forensic Anthropology

Early comments regarding taphonomic data-gathering by physical anthropologists in forensic investigations are found in Krogman (1962:7) when discussing estimation of time since death, although he does not use the term taphonomy:

> The problem of time-elapse since death is so complex that I'm not attempting to tackle it in this book. There are often too many unknowns, not the least of which may be careless or inexperienced exhumation. The soil may tell of primary or secondary inhumation; it

Table 1.2 Taphonomic Time Periods, Analytical Foci, and Datasets for an Exemplar Homicide Victim Transported after Death to an Outdoor Site and Recovered after Skeletonization and Significant Weathering of the Remains

	Analytical Foci		
Taphonomic Periods Being Reconstructed	Reconstruction of Taphonomic Context: (Sequences, and Nonhuman Taphonomic Agents)	Reconstruction of Taphonomic Events: (Particularly Human Perpetrator as Taphonomic Agent)	Reconstruction of Victim
Scene: Predepositional Remains: Antemortem	Context prior to arrival of human remains (learned through research): • Geological • Biological • Ecological • Climatological	Events leading up to deposition (due to human as taphonomic agent): • Antemortem trauma (with vital response) • Trace evidence connected with a previous location or with perpetrator identity • Human as taphonomic transport agent	Discriminate taphonomic changes from indicators of: • Antemortem history • Biological profile • Individual identity
Scene: Depositional Remains: Perimortem	Context at the time of deposition (inferred or extrapolated): • Time of day • Season • Presence of scavenger species	Events at the time of deposition: • Perimortem trauma • Postmortem modification of remains by perpetrator • Trace evidence of trauma (e.g., weapon) or deposition process (e.g., shovel marks)	Identify modifications which suggest: • Cause of death • Manner of death
Scene: Postdepositional Remains: Postmortem	Context changes between deposition and recovery (inferred or extrapolated): • Effect of remains on environment • Taphonomic agents of modification, both the processes and sequences	Events after deposition and before recovery: • Intentional postdepositional disturbance by perpetrator or other humans • Accidental disturbance by humans • Modifications or transport by humans at the time of discovery	Analyze condition of remains to indicate: • Postmortem interval • Transport history • Postmortem modification by nonhuman agents • Postmortem modification by humans at recovery or at autopsy
Scene: Postrecovery Remains: Postrecovery	Context at time of recovery (observed): • Ecological characteristics • Evidence of scavenger species	Events following recovery: • Modifications due to recovery, examination, or storage	Document process of data collection to ensure: • Associations at the scene • Chain of custody

> may yield chemical (acid or base) evidence of rate of decomposition; it may tell of flora and fauna (vegetation and insect action); it may tell of the mechanical factors of movement of [*sic*] water-seepage (a homogeneous tightly-packed soil as in clays or glacial tills, or a heterogeneous soil as in gravels); depth of interment is very important; the swing of seasons and the amplitude of temperature change play their roles (in water deaths temperature and factors of stasis vs. current-movement are basic). The bones themselves give an idea of time-elapse in the presence or absence of ligamentous attachments and the rates of leaching out of fats and other organic content; surface erosions on bones are important, as well as changes in inner architecture (changes in cancellous tissue, in trabeculation seen radiographically). I don't think the physical anthropologist should tackle cause of death.

Although they do not address taphonomic issues in any systematic fashion, El-Najjar and McWilliams (1978) do recommend graves be excavated by an archaeologist with a physical anthropologist there to excavate the remains themselves.* We underscore the value. El-Najjar and McWilliams also propose a standard narrative report format (1978:9–11) to be used by the physical anthropologist in forensic investigations. Included in the format is a section for Condition in which patterns of decomposition are described. In a section proposed for Time of Death, they discuss the necessity of knowing circumstances of deposition, and their sample report mentions scavenger modification. The report format also includes sections for Trauma and one for Death in which possible evidence of the cause of death is discussed.

Stewart (1981) agrees that the physical anthropologist should assess evidence of the cause of death, i.e., the presence of trauma. He also devotes an entire chapter to "Judging Time and Cause of Death," and proposes a list of attributes regarding time of death to be scored, he says, as present or absent: (1) odor, and its intensity; (2) soft parts, and their location; (3) adherent earth (clay, loam, or sand); (4) adherent vegetation (twigs, leaves, grass, or moss); (5) adherent insects, living or dead, including immature stages; (6) tooth marks; (7) stains and/or bleaching; and (8) adipocere. In the subsequent pages he devotes complete sections to necrophagous insects, minimum time of skeltonization, varying frequency of carnivores, shielded remains, adipocere formation, effect of a shallow burial, residual bone nitrogen, root penetration, and staining and bleaching.

Stewart (1981:74) provides strong cautions against estimating time of death on the basis of skeletal appearance, citing the possible fresh appearance of long but deeply buried bone. He notes that the skeletons from the Korean war recovered "from the shallow graves of the American soldiers who had been held for varying lengths of time in prisoner-of-war camps were virtually indistinguishable in appearance from prehistoric skeletons recovered archeologically; that is, they gave little if any visible evidence of containing organic matter and were beginning to show breakdown of the cortical surfaces."

Buikstra and Ubelaker (1994) include a chapter "Postmortem Changes: Human Taphonomy" in their handbook of data collection standards for human skeletons. This contribution systematizes observations of *archaeological* bone with regard to basic alterations of color, surface, and shape. They recommend routinely collecting data on weathering, discoloration, polish, cutmarks, evidence of rodent and carnivore gnawing, and

* This issue has been a topic of conversation in recent meetings of the American Academy of Forensic Science, Physical Anthropology Section, and is a theme in a special, upcoming volume of the *Historical Archaeology* (Crist, 2001; Haglund, 2001; Haglund et al., 2001; Owsley, 2001; Scott and Connor, 2001; Stover and Ryan, 2001).

other forms of cultural modification including creation of artifacts. These characteristics are also applicable in forensic taphonomy. In contrast to our approach here, Buikstra and Ubelaker place "premortem and perimortem fractures, wounds, and abrasions" (p. 106) in the chapter on paleopathology, thus separating perimortem trauma from taphonomy. However, cutmarks and burning remain in the taphonomy chapter because they are assumed to be connected with mortuary ritual.

The taphonomic data collection protocols recommended in Buikstra and Ubelaker (1994) are fairly straightforward. All modifications are noted with the element and location. Munsell Color Charts are to be used for color observations; they offer a nominal scale for surface texture of burned bone. Weathering changes are to be recorded using Behrensmeyer's (1978) categories. Other taphonomic changes (rodent gnawing, carnivore chewing, artifact creation) are recorded with drawings and/or photographs. Cutmarks are described by the number, length (mean and range), and a cast of a representative example (optional).

The Perimortem Problem

Forensic reconstructions frequently focus on discriminating trauma that occurred at or immediately prior to the time of death (and which, therefore, provide evidence about cause and manner of death) from those occurring after that. But the definition of death is a medicolegal one, based on medical soft tissue observations of the absence of heart and brain activity. Aside from the vital reaction of bleeding or bone remodeling with healing, we have no proxy for demonstrating that a traumatic event preceded death. The morphology of perimortem wounding to bone cannot, by that alone, be differentiated from postmortem damage to fresh or nearly fresh bone.

As mentioned above, during the early postmortem period, before bone loses its moisture and organic components, it tends to respond to modification agents as if it were fresh. However, these patterns are not invariable or always diagnostic. The loss of organics and water is gradual and dependent on the microenvironment.

As bone elements are exposed to their surroundings, their composition changes. There may be staining of outer layers, or weathering, or mineral uptake/loss into soil or water. Once bone surface color is altered, or significant weathering has occurred, it becomes easier to differentiate perimortem from postmortem modifications, as the latter will tend to disrupt the outer layer and expose unstained or unweathered bone. Certainly, more research is needed to establish descriptive standards of bone condition using chemical and physical properties in addition to visual characteristics to measure 'freshness'. Sauer (1998) has offered a brief protocol for assessing the timing of a particular element or defect.

Humans Are Taphonomic Agents

One topic that has been an important issue in both forensic and archaeological investigation is that of humans as modifiers of remains, human or nonhuman. We believe the identification of common patterns of human modification of humans, whether due to homicide, dismemberment, warfare, scavenging, cannibalism, or burial ritual, should be included as an essential dimension of taphonomy. The differentiation of human from other agents causing long bone breakage has been debated for early hominid sites, in the controversy surrounding the peopling of the Americas (Bonnichsen and Sorg, 1987), and with respect to cannibalism (Graver et al., Chapter 16, this volume; Turner and Turner, 1999; White, 1992).

A key concept here is the equifinality of some taphonomic processes (Bunn, 1991), i.e., more than one agent producing the same or similar taphonomic signature. Is it possible, for example, to identify diagnostic features or signatures of particular taphonomic agents (e.g., see Haglund et al. (1988a,b) regarding canids)? In a useful review of literature, Bunn points to the need for more research, but comments on the importance of looking at complete patterns, and in context, as well as the importance (echoed by many others) of microscopic observation. He particularly notes the need for more research on cutmarks, bone fracture biomechanics, carnivore modification patterns, faunal ecology, and actualistic studies of site formation. During the last decade these topics have indeed received more attention.

Not only is human agency an issue, but the discrimination of peri- and postmortem can become the key issue in identifying human agency. Diez et al. (1999) describe the Atapuerca site in Spain, which dates to the Lower and Middle Pleistocene. They conclude that the array of butchered mammalian food includes humans, and they group humans with other mammals of similar weight. They list characteristics of the butchered bones, focusing on the identification of perimortem defects. The butchered remains are highly fragmented with few elements intact apart from teeth and articular bones. The fragments have a mixed representation of right-angled breaks (attributed to diagenesis) and oblique breaks (interpreted as perimortem). They note "curved, V-shaped fractures" as a "good discriminatory trait between fresh and old fractures" (1999:631). They find that smooth fracture edges, proposed by many as a characteristic of fresh breaks, do not discriminate; these are attributed more to a dynamic (vs. static) force impacting the bone. Jagged edges, they assert, are more likely related to the porosity due to loss of organic matter, low crystallinity, and non-mineralized tissue. Smooth edges are related to "compact structures, such as green bones with organic material still preserved in the Haversian and osteon canals, or fossil bones where mineralization and crystallization have occurred in the Haversian and osteon canals" (1999:631–632). They comment that a high frequency of bone fragments in which bone circumference is only half represented is more characteristic of scavenging or butchering; many complete shaft diameters, on the other hand, more likely represent postdepositional breaks. They also include observations of surface modifications related to fracture by humans, including impact points, flakes or notched fractures (conchoidal scars), commenting that most have associated hackle and rib marks which characterize green bone breaks according to Johnson (1985). Finally, they identify and extensively describe the cutmarks differentiating sawing from scraping, as well as skinning, viscera/periosteum extraction, dismembering, and filleting.

Human agency is critical in the resolution of human rights abuses, including mass fatalities or mass burials as addressed by many in this volume. Haglund provides a conceptual framework for mass graves and Schmitt discusses some of the taphonomic implications of human rights abuses. Skinner addresses a frequently overlooked human taphonomic activity, postmortem alteration of burials, sometimes long after the original event. In a parallel, but prehistorically focused, analysis, Darwent and Lyman address the discrimination of postdepositional modification of nonhuman bones (limited to small, dense tarsals, carpals, and phalanges). Darwent and Lyman seek to quantify the rather complex relationships among shape, size, food value, and diagenesis pertaining to these selected elements. They test hypotheses proposed by Marean regarding the detection of postdepositional damage using small, dense faunal remains which are less likely to be broken (see discussion below), as opposed to the patterns of human food utilization patterns.

Of course, modern forensic cases incorporate a varied array of human tool use, and tend to include relatively deviant behaviors. The forensic research is perhaps the clearest record of human conspecific predation. Symes et al. (Chapter 21, this volume) focus attention on several cases illustrating particular types of sharp trauma from tools. And Saul and Saul demonstrate the use of very small or subtle modifications to identify sharp trauma evidence. A parallel archaeological study described the patterning of ritual Mayan decapitation.

The differentiation of human-induced trauma from nonhuman predation or scavenging is based on familiarity with taxon-specific patterns of bone and soft tissue modification. Berryman (Chapter 25, this volume), for example, provides an unusual case of pig scavenging of human remains, documenting and illustrating the modifications due to dental morphology, mastication, and feeding patterns (see also, Kerbis et al., 1993, for examples involving chimpanzee remains). Taxon-specific patterns have been shown to have a large range of variability, however (Saavedra and Simonetti, 1998), and much more research needs to be done to document and analyze such signatures.

In an important example of the potential crossover between forensic and archaeological research, Gargett (1999) addresses the issue of identifying human agency in buried human remains (intentional burials), particularly for a number of so-called Middle Palaeoloithic burials. He concerns himself with the decomposition process, citing research by Haglund (1997), Micozzi (1997), and Galloway (1989), discussing the possible impact of decomposition sequence, rigor mortis, and rapid drying on evaluating burial position. The issue for these archaeological sites is whether burial (e.g., due to rapid sedimentation or cave roof falls) might occur prior to decomposition and disarticulation, thus imitating intentional burial. Another issue is the extent of disarticulation. For this author bones can remain "articulated"* following loss of flesh, assuming burial protects them from movement; it is important, therefore, to assess how close they are (at recovery) to anatomical position. He suggests focusing on three key processes: decomposition, disarticulation, and likelihood of disturbance. Gargett concludes with a set of factors to assess in evaluating whether a burial was purposeful; these include stratification, completeness of remains, articulation pattern, unequal preservation of parts, peri- vs. postmortem fragmentation patterns, position of remains, evidence of disturbance, characteristics of associated bedrock or cave, sedimentation pattern, and evidence of bioturbation.

A related debate about human agency is going on regarding the Klasies River Mouth site in South Africa, dating to the Last Interglacial. These hominids are anatomically near-modern, but did not use Upper Paleolithic tools. The question regarding their associated faunal remains is whether the hominids had hunted them or merely scavenged them, and much of the debate centers on which body parts are represented (scavenging should result in disproportionately more limb bones) (Binford, 1984; Blumenschine, 1986). Milo (1998) uses a wide range of analytical techniques to evaluate the array of faunal bones and the butchering marks, including assessment of minimum numbers, large carnivore scavenging signatures, and experimental butchering. In research very much applicable to the types of case studies in Symes et al., (Chapter 21, this volume) he outlines the morphology of cuts vs. stabs, the absolute necessity of microscopic examination (only 32% of marks he made in his experiments were macroscopically visible on fresh bone), and the mediation by

* The terms *disarticulation* and *articulation* will be discussed more fully in the section Taphonomic Observations and Terminology.

postdepositional deterioration (he estimates 30% of marks become undetectable). The conclusion is that the hominids were hunting, not scavenging.

In a related article about this site, Bartram and Marean (1999) examine the importance of recovering, identifying, and analyzing midshaft bone fragments in the differentiation of hunting and scavenging. They also discuss the ongoing debate in archaezoological and taphonomic research regarding the applicability of actualistic studies and uniformatarian theory. Their conclusion, aided by ethnographic examples, is that scavengers raid human sites after hunted animal bones have been processed for marrow (with heavy fragmentation of midshafts), differentially removing the epiphyseal portions. Bias is introduced when archaeozoologists subsequently exclude these midshaft fragments from their analysis because they are coded as nonidentifiable during the analysis.

Building Models and Data Sets

Experimental taphonomic research, also called *actualistic research*, is an important common ground between traditional, paleontological taphonomy and forensic taphonomy (Gifford-Gonzolez, 1981). In actualistic experiments a particular taphonomic process is the focus for model building; key independent variables are controlled, and observation of the dependent variables can be systematized, e.g., the now-classic studies of fluvial transport of human remains in the paleoanthropological literature (Behrensmeyer, 1982; Boaz and Behrensmeyer, 1976; Hanson, 1980) or of the decomposition process by human cadavers in the forensic literature (Bass, 1984, 1997).

In other actualistic approaches, the investigator studies a process seen in the fossil (or forensic) record by observing the same process in a natural setting, e.g., the studies of mammalian scavenging in the archaeological literature (Haynes, 1980, 1982; Brain, 1981; Hill, 1979). The forensic counterpart of these studies is the systematic analysis of a series of cases that bear certain structural similarities, such as the study of cases of canid scavenging of human remains by Haglund et al. (1988a,b) in order to construct a stage model of this process, or the study of cases of terrestrial decomposition (Galloway, 1997; Rhine and Dawson, 1998; Sorg et al., 1998) or marine decomposition (Boyle et al., 1997; Haglund, 1993; Sorg et al., 1997) in order to model the decomposition process regionally. The control in these case series is that time since death is known and a single investigator with a consistent and systematic approach to his or her cases is present. Data collection must be comparable across cases and, ideally, the data themselves are reported as part of the presentation of the model, enhancing the opportunity of replication or comparison by other scientists.

A third type of actualistic research is the case study. Although some forensic cases are never solved with respect to victim identity, time, or cause and manner of death, many are. Thus, investigators have a luxury (or challenge) not afforded to colleagues doing traditional archaeology or paleontology: to learn whether hypotheses about the case were correct. That is, inferences and estimates proposed in the analysis are tested as further details of the case are revealed. It is this aspect of forensic taphonomy that offers a new type of data to the field of taphonomy generally. The variables are not under investigator control, as they are in experimental design or even systematic naturalistic observation. Case studies offer the opportunity to enrich explanation through enhanced observation and analysis, particularly in terms of learning about the range of variation. In Symes et al. (Chapter 21, this volume) two of the cases presented include confessional statements by perpetrators describing the sharp force trauma they used, corroborating the hypotheses of the investigators

Forensic scientists have been constructing actualistic models of taphonomic change using nonhuman animal proxies for decades, with pigs being the most common choice due to their comparable mass, lack of fur, and availability (Anderson and Cervenka, Chapter 9, this volume; France et al., 1992, 1997; Haskell, 1989; Janaway, Chapter 20, this volume; Komar, 1999; Morton and Lord, Chapter 8, this volume; Payne, 1965; Payne and King, 1972). Others have done longitudinal studies with donated human cadavers under very controlled conditions (Bass, 1984, 1997; Rodriguez and Bass, 1985; Voss et al., 1992). A naturalistic study of rainforest taphonomy has recently been published utilizing the recovery of the remains of chimpanzees who died of natural causes, predation, or poaching (Peterhans et al., 1993). The purpose was to test the hypothesis that the primate fossil gap around the Pliocene might be due to the bone-destroying taphonomy of tropical forests. Chimpanzees are also potential models of human remains in forest settings. They conclude that some remains are undamaged even after several years, as long as the soil is not acid, permitting the accumulation of remains.

Taphonomic Observations and Terminology

The use of terms differs from one discipline to another. While a term may be well understood and functionally adequate, when it is applied in a new disciplinary context, its use may lead to misunderstanding or dwindle to meaninglessness. The lack of interdisciplinary term conventions may exacerbate misunderstanding, create error of assumption, and alter the inferences themselves. For example, the use of the terms articulated and disarticulated has different meanings when applied by forensic pathologists than by some forensic anthropologists.

Articulation is the state of having parts connected by joints. The word is derived from the Latin term for joint: articulus. Variations of the definition of articulate are (1) to join together so as to allow motion between the parts, or (2) united by means of a joint, or (3) to make of parts united (*Webster's Collegiate Dictionary*). With regard to anatomy specifically, an articulation is a place of union or junction between two or more bones of the skeleton (*Dorland's Illustrated Medical Dictionary*).

Contrarily, disarticulation is defined as the separation or amputation of a bone at a joint; to disarticulate is to become disjoined by flexible joints (*Webster's Collegiate Dictionary*, *Stedman's Medical Dictionary*).

With these definitions in mind, the medical use of articulation is generally related to anatomical relationships or associations between bones *maintained by soft tissue connections at joints*. When soft tissue is absent at the joint, bones are in fact disarticulated, even though they remain in relative anatomical position. Occasionally, remains may actually be held in complete anatomical relationship by the soil matrix, but generally elements will have moved slightly out of position. Hence, the forensic pathologist describing a fully skeletonized remains, arrayed carefully in anatomical position (but not joined by soft tissue), would characterize such a skeleton as disarticulated and in anatomical relationship. This same set of skeletal remains might be described as articulated by some forensic anthropologists (Bass, 1962; Ubelaker, 1974, 1989; and numerous others), a usage connoting soft tissue presence with which we disagree. Such terminology confuses connectedness with relative anatomical relationship or approximation of bones at a joint. A more precise application would separate descriptions of anatomical relationship *in situ* from inferences of the condition of remains when buried.

The foregoing misapplication of "articulation" has a range of consequences. First is the potential to introduce an erroneous assumption. When bones are connected at the joint by soft tissue, one can correctly assume they belong to a single individual. When bones rest in anatomical relationship, but are not physically connected, they may likely but not necessarily belong to the same individual (see Saul and Saul, Chapter 4, this volume). One must look to other contextual factors, such as the number of individuals and their relative positions.

A second problem introduced by misapplying this or other terms is the potential loss of that term's inferential power. For example, an important inference that can be drawn from the proper use of the term disarticulation is that the bone elements are now independent units, and are likely to be moved independently. This is of utmost significance in a taphonomic context, when dealing with issues of scavenged or otherwise transported remains. Transport units can be inferred to be (or to have been) joined and moved as a single entity, and therefore articulated.

In Chapter 5, this volume, Roksandic pays particular attention to the interaction of decomposition processes and burial contexts. She builds on research by Duday (1978, 1981, 1987a,b and Duday et al. (1990) that considers types of articular anatomy, their behavior during the postmortem period when buried, and inferences regarding burial practices. She shows that with careful excavation in certain context types, one can infer the condition of the remains when buried. Saul and Saul explore the mutual benefits of archaeological and forensic case experience in differentiating taphonomic agents and contexts. In one archaeological case inferences about articulation become critical in the sorting of commingled remains.

Biogeographic Context

To more fully understand issues, dynamics, and consequences of taphonomic processes, it is vital to collect higher resolution data on the ecological context from which individual cases are recovered. The goal of gathering these data, not generally part of forensic investigations, is to make forensic taphonomic research more systematic, comparative, and empirically based. This is a similar approach to that suggested by Potts (1998) in his treatment of an environmental hypothesis of hominin evolution. Conventionally, even when taphonomic issues are broached in the pursuit of death investigation data, environmental variables are poorly observed and little examined.

The corpse becomes part of an ecological setting (see Behrensmeyer, 1975, and Behrensmeyer et al., 1979, for early examples linking paleoanthropology, taphonomy, and paleoecology), in some sense even creating a new ecological community delimited by physical and biotic parameters, and having a particular history. (Complications may be introduced if the place of death, place of deposition, and the place the modifications occurred are different.) For each location, questions must be asked about the emerging ecological community centered on the remains, and about the climatological, physical, and biological parameters that may have influenced the modification process. Then, based on a knowledge of generalized taphonomic processes combined with information about the specific location, decisions should be made concerning at what levels these should be documented (Haglund, 1998). Following these decisions regarding context, choices should be made about methods and approaches to data gathering and analysis of the remains themselves. This two-step process will lend power to the theory building that may result.

For example, a variable as elemental as temperature, in routine death investigations, is usually documented by recording ambient atmospheric temperatures at the scene, including known maximum/minimum temperatures for the area along with seasonal and diurnal fluctuations. However, when considering putrefaction processes, air temperature is less important than temperatures on or near the surface. Coe (1978) pointed this out in his study of decomposition in elephant carcasses. In any local setting there are a host of temperature-driven microenvironments dependent on absorption of radiant energy. For a 3-day period, Coe found temperatures on open ground and scrub were between 25 and 28°C, but maximum surface open-ground temperature was 45 to 50°C in mid-afternoon. On rock surfaces, temperature approached 60°C, and for forest-shaded areas, the maximum surface temperature was only 28°C with a daily range of only 8°C. Among forensic entomologists, for example, the critical nature of temperature is already realized. Hence, more refined temperature observations are being demanded and more routinely made, increasing the resolution of their interpretations. In this volume, Anderson and Cervenka (Chapter 9) explore regional intra-species variation in the interpretation particularly of time since death for the Canadian northwest. Species-specific regional variation has been implicated in several taxas, including, for example, predation by owls (Fernandez-Janvo et al., 1999; Saavedra and Simonetti, 1998) and distribution of plant pollens (Horrocks et al., 1998). It is critical to take such potential variation into account by developing regional databases and comparing them.

Marine settings offer an important testing ground for taphonomic studies. The literature on marine taphonomy is rich (Donovan, 1991; Martin, 1999; Parsons and Brett, 1991). Research on mollusks and foraminifera provides interesting models for the decomposition and dissolution of the (also calcium-based) human skeleton (Walker and Goldstein, 1999) within the Taphonomically Active Zone (TAZ) or bioturbation zone (Davies, et al., 1989). Walker and Goldstein (1999) propose a model for preservation of hardparts which may be applicable to skeletal remains. They comment that, for mollusks, time spent on the surface prior to burial is much more likely to drive the condition of the remains than is time since death. They have also concluded that burial may not be so much of a preservative as has been thought. They use a concept which may be useful in guiding recoveries in forensic settings: dominant taphonomic processes, which may be regionally specific, but discoverable, in terms of their applicability to common forensic problems.

Bogs and Aquatic Contexts

Human bodies have been recovered from an enormous variety of climatological, geographic, and physical contexts. Many forensic cases, with little archaeological comparison, are recovered from marine, riverine, or lacustrine environments. These cases tend to create considerable taphonomic difficulties due to the effects of extensive transport and/or the problems identifying and describing a meaningful, essentially 3-dimensional, taphonomic context. Haglund and Sorg provide in Chapter 10 in this volume a brief overview of taphonomic issues in aquatic settings. Ebbesmeyer and Haglund (Chapter 11) expand on particular circumstances and contextual issues: shipwrecks and ocean currents.

In some contexts such as bogs, long-term preservation of human remains is possible. Brothwell and Gill-Robinson (Chapter 6) compare the condition and contexts of an impressive series of bodies found in bog settings. A number of these cases are suspicious deaths. The bog microenvironment is a highly acid, moist, and anaerobic environment with well-known characteristics. Yet the variation is remarkable.

Mass Fatalities and Mass Graves

Mass Graves and Human Rights

The reach of forensic inquiry and research has recently been extended in a prominent way beyond the purview of state and federal legal systems to international and pan-national contexts. That death investigations are done in international circumstances is certainly not new, but the explicit application of taphonomic approaches in these contexts is. In particular, this includes the exhumation and interpretation of traumatic deaths and mass graves due to war crimes and human rights violations, as well as the recovery of remains and the investigation of deaths in mass disasters.

Haglund's introduction (Chapter 12) in this volume to some of the terminology and conceptual issues regarding mass graves leads a series of chapters focused on case examples of larger-scale human death due to disasters and human rights abuses (see also, Burns, 1998). Simmons (Chapter 13) describes a cave context, comparing it to a similar karstic cave australopithecine site, and discusses the recovery and interpretation issues. Sledzik and Rodriquez (Chapter 17) discuss mass fatalities such as plane crashes and the effects of these events on remains: burning, fragmentation, and scattering, in particular, and the resulting taphonomic implications (see Lyman, 1987, for a faunal analysis of a mass disaster, the Mount St. Helens volcanic eruption). Schmitt (Chapter 14) focuses on some of the legal issues and the resulting taphonomic implications for search and recovery methods for clandestine graves. Skinner et al. (Chapter 15) review instances of postburial disturbance by humans, a problem that frequently impacts interpretations in these cases.

Scattered or Commingled Remains

Many taphonomic agents scatter remains. Some situations provide significant challenges for archaeological techniques and interpretation. Haglund et al. (Chapter 7) provide a discussion of plow-zone contexts and the recovery of human remains, describing modern equipment and its effects on buried remains. Ubelaker (Chapter 18), on the other hand, provides a comprehensive review of the types of issues that emerge in identifying and sorting commingled remains; he provides a literature review as well as case studies to illustrate several common situations.

Reconstructing Taphonomic Context vs. Taphonomic History of the Remains

One advantage of this interdisciplinary field is the possibility for independent observations of the same data sets by different investigators. This can become more important when considering the problem of analytical focus. On the one hand, the condition of the remains constitutes evidence for a particular taphonomic context. On the other hand, one needs to reconstruct the taphonomic history of the remains using data about the taphonomic context. To minimize circularity, it is best to focus first on the context, using the perspective of several disciplines if possible, then focus attention on the condition of the remains as dependent variables.

Ethics and Standards of Practice

Important ethical questions arise when the processes of forensic case investigation and data collection for research overlap, not only with regard to actualistic studies but also data collection incidental to case investigation. A delicate balance must be struck between potential benefit to the public and potential costs regarding how bodies are treated.

The use of donated human bodies requires care and sensitivity. States, nations, and cultures differ in their tolerances, restrictions, and laws with regard to the treatment of human corpses for educational or research purposes. In most U.S. states, the collection and retention of any body part for study must be done only for legitimate inquiries in the case, unless the body has been donated for research. The use of nonhuman animal proxies also raises issues concerning humane treatment as well as levels of necessity for the research use.

Since most forensic investigations are funded by public (governmental) or quasi-public (nonprofit organization) dollars, and since these investigations are by their nature conducted in a humanitarian or judicial role, resources are generally limited and investigator conduct is in the public domain. Regardless, the sensitive nature of the situation demands discretion. Thus, for example, resources must be appropriated on the basis of the needs of the particular case rather than any research agenda, minimizing damage to the body, and maximizing investigative potential.

Nevertheless, investigatory quality (precision, thoroughness, accuracy, effectiveness) is enhanced by the use of basic standards and protocols, the use of which leads to routine collection of comparable sets of data (Buikstra and Ubelaker, 1994; Moore-Jansen et al., 1994). Whereas not all of these data may be seen as critical or even necessary in a particular case, the process of systematic coverage tends to reduce omissions and makes it more likely that data will be available in the event there are subsequent investigations.

Although forensic taphonomy has emerged as a significant focus for research since our earlier efforts to link the two fields (Haglund, 1991; Haglund and Sorg, 1997a; Sorg, 1985), there is still much to do. The challenge continues in constructing well-documented series of cases, and in making the data available across investigators for comparative research. Additionally, we feel it is time for setting some standards in forensic taphonomic data collection, particularly for outdoor scenes, including systematic collection of minimal region-specific and site-specific, comparative information about temperature (current, nearest weather station, seasonality; see Anderson and Cervenka, Chapter 9, this volume), climate (particularly humidity and precipitation), soil, scavengers (mammalian, crustacean, avian, and arthropod), plants, and site history, as well as case-specific details about the condition of the remains and details of the deposition.

Recommended Forensic Taphonomy Report Protocol

Most forensic anthropologists use some variation of the report format recommended by El-Najjar and McWilliams (1978). During the last decade, however, the scope of practice has broadened somewhat to include scene visits and the recovery of remains, mass fatality incidents, and human rights investigations involving excavation. Although the use of archaeological techniques in forensic recoveries was pioneered much earlier (Brooks, 1975; Morse et al., 1983), it is only recently that anthropologists have been asked routinely to recover remains (Haglund, 1993; Reichs, 1998). This signals a broadening of the scope of practice for forensic anthropology in the United States to more closely resemble forensic archaeology practice in the United Kingdom (see Hunter's Foreword, this volume). There has been a parallel

Table 1.3 Updated Forensic Anthropology Report Format

Part 1: Introduction	• Background and chain of custody
Part 2: Taphonomy	• Document microenvironment at scene • Document remains *in situ* • Document recovery process • Inventory remains • Describe condition, including an assessment of taphonomic modifications due to transport, burial, decomposition, scavenging, weathering • Incorporate reports from other disciplines such as entomology, botany, and geology • Estimate postmortem interval
Part 3: Biological Profile	Develop biological profile (individual and population characteristics) • Age • Sex • Stature • Discrete traits and anomalies (inherited and acquired) • Population ancestry • Pathology and evidence of medical history
Part 4: Individuation and Identification	• Combined pattern of anomalies, pathological conditions, or other traits known or documented for this individual • Compare remains and antemortem records of possible matches • Dental records • Radiographs • Medical history • Photographs • Facial imaging • DNA analysis
Part 5: Reconstruction of Death Event	• Trauma: types, location and patterning, trajectories, sequences, potential weapon classes • Document process of differentiating perimortem trauma from postmortem changes • Apply additional specialty analyses from other sources, e.g., tool marks, fracture biomechanics, trace evidence, histology, radiography

development of forensic taphonomy as a theoretical umbrella for interpreting postmortem processes in context. As a result, we recommend altering the basic forensic anthropology report format to include four parts, one of which focuses explicitly on taphonomy (see Table 1.3). Even when the formal report format must be abbreviated by request of the jurisdiction or function, the data collection and analysis that lie behind it should be thorough.

Broader Professional Issues

The forensic sciences are a fast-evolving cluster of applied disciplines that operate independently as well as in interdisciplinary teams. As these forensic fields mature and develop, they expand to incorporate new methods and theories (often borrowed or adapted from