POSTMORTEM CHANGE IN HUMAN AND ANIMAL REMAINS

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A Systematic Approach

By

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PREFACE

The identification of questions to be asked in science must be tempered by the availability of the means to answer them. Taphonomy has developed as a potentially powerful tool for providing increased means for answering questions about postmortem change. Little has appeared in the forensic medical or anthropological literature concerning postmortem change and time interval since death (Bass 1984). Stewart (1979; 71) devotes less than eight pages out of 300 for determining time since death stating "there is no escaping the fact that for most skeletonized remains, estimation of time since death usually is little more than an educated guess." Other forensic anthropology texts devote less space to determining time since death (Krogman, 1962; El-Najjar and McWilliams, 1978; Krogman and Iscan, 1985; Ubelaker, 1989). In the meantime, an extensive literature on taphonomy has developed in archaeology from historical observations and modern experimental approaches.

An underlying assumption of science is an entropic or centripetal bias in that most natural forces are regarded to tend towards disorganization ("things fly apart," or fall apart). Archaeologic theory continually seeks explanations for why things come together. Taphonomy may be regarded as the study of entropic forces which disorder material remains, cause disturbance of the archaeologic record, and to some extent homogenize material features.

However, these taphonomic transformations are patterned based upon underlying physical, chemical and biological principles. Thus, known patterns for the behavior of remains through taphonomic transformations may lead to information gains, rather than losses, in the archaeologic record.

Postmortem modification and transformation of human and animal remains is determined by the taphonomic principles which govern behavior of all material in the archaeologic record. An approximate chronologic order of the action of taphonomic factors on human and animal remains is given in this book. Taphonomic transformation that occurs early in the postmortem depositional history of remains necessarily conditions the characteristics of changes which come after. The order of operation of taphonomic factors may also vary somewhat within well-defined ranges.

Applications of the taphonomy of organic remains may be found in paleopathology, bioarchaeology, physical anthropology, paleontology, faunal analysis, and historical archaeology and forensic medicine.

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Chapter I

INTRODUCTION: TAPHONOMY IN THE STUDY OF POSTMORTEM REMAINS

SCOPE OF TAPHONOMY

Taphonomy may be described as the "transferral of organic remains from the biosphere to the lithosphere" (Olson, 1962). The term *taphonomy* was coined by the Russian paleontologist, I.A. Efremov (1940), from the Greek words for tomb or burial (taphos) and for law or system of laws (nomos), to denote a subdiscipline of paleontology devoted to study of the processes that operate on organic remains after death to generate archaeologic skeletal deposits. Postmortem processes affecting organic remains were divided by Muller (1951) into two types of taphonomic transformations: biostratinomic and diagenetic. Biostratinomic processes, first coined by Weigelt (1927), includes all taphonomic transformations from death through burial of remains. Diagenetic processes deal with transformation in soil of organic material to mineral, or fossilization. Biostratinomic processes have been investigated for invertebrate, vertebrate and hominid remains in several early studies, as shown in Table 1. Bone modification and attrition (alteration within primary site) and destruction and transport (disappearance from primary site) are within the biostratinomic realm from death to final burial. Differential responses of bones to these processes relate to biologic as well as taphonomic factors.

Three types of biologic "assemblages" are important with respect to taphonomy: (1) biocoenose is the assemblage of living organisms, (2) thanatocoenose is the assemblage of organisms associated through death, and (3) taphocoenose is the assemblage of organisms localized in an archaeologic context (Voorhies, 1969). Mammals comprise the majority of organic remains studied at hominid sites (Dodson, 1973) and are most relevant to determining patterns of human remains. Grey (1973) has attempted to define the process of deposition of mammalian skeletal assemblages using both biological and geological principles. Grey defines the taphocoenose as a regional association of species in which related,

Table 1. Early Studies of Postmortem Processes

Process	*Invertebrate*	*Vertebrate*	*Human*
Disarticulation	N/A	Weigelt (1927) Toots (1965) Clark et al., (1967) Voorhies (1969) Hill (1975, 1976, 1979, 1980)	Dart (1956, 1957) Brain (1967, 1980) Crader (1974)
Transport (aqueous)	Bancot (1953)	Voorhies (1969)	Shipman (1977)
Attrition (weathering)	Craig (1953) Rigby (1958)	Voorhies (1969)	Crader (1974)
Biological Agents (scavenging)		Voorhies (1969) Payne (1965) Sutcliffe (1970)	Hughes (1954, 1958, 1961) Vrba (1975)

site-specific biotic factors (e.g., habitat) and geologic factors (e.g., sedimentation patterns) determine the chances for preservation. Death determines the composition of the taphocoenose. Causes of death may be normal attrition (very young and very old) or catastropic (plague, flood, famine, or natural disaster). Average life spans influence relative representation and accumulation of species. Relative size determines preservation, in that smaller animals are subject to greater destruction during scavenging and burial.

A taphocoenose may be allocthonous (an assemblage arising through transport of remains away from a site) or autochthonous (deposited at the primary site). Thus, skeletal assemblages may be recognized as representing proximal or distal communities, based on place of origin of skeletal elements. The degree of transport of remains is related to their density and degree of disarticulation. An anataxic assemblage is uncovered after burial and again subject to transport and other taphonomic transformations at this stage. The factors influencing human and animal remains postmortem are shown in Table 2.

It may well be considered that the biocoenose is related to biotic factors. Thanatic factors (mortality) result in creation of a thanatocoenose. The composition of a taphocoenose is determined by taphonomic transformation in the form of perthotaxic, taphic and anataxic factors. Finally, the validity and reliability of information from skeletal remains are determined by sullegic and trephic factors; what may be referred to as

Table 2. Taphonomic Factors Influencing Human and Animal Remains

Chronology	*Factor*	*Stage*	*Agents*
1	Biotic	(antemortem)	lifestyle, habitat
2	Thanatic	(perimortem)	mortality
3	Perthotaxic	(postmortem, preburial)	predation, scavenging
4	Taphic	(burial)	transport, pedoturbation, diagnesis
5 (return to 3)	Anataxic	(uncovered after burial)	exposure/weathering
6	Sullegic		collecting, sampling
7	Trephic		curatorial

chain of custody in the forensic setting. Taphonomic factors determine the proportion of the target population of an ecosystem, and quantitative and qualitative content of skeletal assemblages, available for study in the archaeologic record. Sampling factors determine what proportion of the study population is in fact studied, and the reliability of that sample for study. Both taphonomic factors and sampling factors enter into the interpretation of human and animal remains postmortem.

Starting Conditions	*Agent of Modification*	*Ending Conditions*
Target population	Taphonomic factors	Study population
Study population	Sampling factors	Sample population
Sample population	Statistical factors	Sample fraction

Grayson (1978) has developed indices of number of identified skeletal elements, and number of identified specimens per taxon (NISP) for faunal analysis, which may be useful in taphonomy. He identified several transformational factors and phenomena relevant to taphonomy and sampling:

(1) Dismemberment pattern
(2) Numbers of identified specimens vary from species to species
(3) Usage assumes equal effects of chance on breakage
(4) Differential preservation
(5) Curatorial-collection techniques
(6) Entire skeletons skew abundance

Taphonomy is relevant to points (1), (2), (3) and (4), while sampling is relevant to points (2), (3), (5) and (6).

Taphonomy as a systematic study of postmortem change can be related to traditional forensic pathology in the scheme shown in Table 3 for determination of postmortem time interval. Taphonomy enters into forensic interpretation in Phases III thru V as shown in the table. Phases I and II are not properly in the scope of the present volume. Phase VI generally takes us beyond biological and physical processes of taphonomy into changes that are geologic. However, an understanding of taphonomic processes during Phases III thru V may be important to interpretation of geologic findings.

STUDIES OF POSTMORTEM PROCESSES

Studies of postmortem taphonomic processes have been accomplished by a number of investigators for invertebrate, vertebrate and hominid remains regarding disarticulation, aqueous transport, attrition (weathering) and scavenging (biological agents). Early studies are summarized in Table 1.

Existing studies of postmortem decay and disarticulation have focused on three primary methodologies: (1) observation of naturally-occurring sequences of decay and disarticulation, (2) experimental observation and documentation of decay and disarticulation sequences, and (3) observation of attrition by predators and scavengers to animal remains.

Observational Studies

A number of observations have been made on natural sequences of decay and disarticulation. Weigelt (1927) studied cows on the Gulf Coast of the U.S., and Toots (1975) observed disarticulation sequences in semiarid regions of Wyoming. Shafer (1978) studied decay and disarticulation sequences of sea birds and mammals in the North Sea and adjacent coastal regions. Completely different criteria and sequences have been proposed by these investigators, and their results are difficult to reconcile. The incompatibility of results seems to be due largely to the wide variety of animals used and conditions under which they were studied. Meaningful generalizations on natural sequences of decay and disarticulation have been difficult to formulate on the basis such observations.

Experimental Studies

Dodson (1973) has carried out experimental observations of decay and disarticulation in small mammals, reptiles and amphibians in the laboratory. The applicability of this work on microfauna to megafaunal and human remains is unclear. Two painstaking studies were conducted