Zooarchaeology

Zooarchaeology is a detailed reference manual for students and professional archaeologists interested in identifying and analyzing animal remains from archaeological sites. It draws on material from all over the world, covering a time span from the Pleistocene to the nineteenth century AD, with the emphasis on animals whose remains inform us about many aspects of the relationships between humans and their natural and social environments, especially site formation processes, subsistence strategies, and paleoenvironments. The authors discuss suitable methods and theories for all vertebrate classes and molluscs, and include hypothetical examples to demonstrate these. There are extensive references and illustrations to help in the process of identification.

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ZOOARCHAEOLOGY

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Dedicated to our families and colleagues in appreciation of their support and inspiration

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PREFACE

This volume is directed to all those interested in the recovery, identification, and analysis of animal remains from archaeological sites. Our intent is to present standard zooarchaeological methods and to suggest the circumstances under which they may be most successfully applied. Because we believe a background in both anthropology and biology is important for a balanced approach to zooarchaeology, both relevant anthropological and biological information are reviewed. The exchange among biological, paleontological, archaeological, and ethnographic research is the important defining characteristic of the study of animal remains linking the following pages. The development of zooarchaeology owes much to an awareness of the importance both of ecological relationships on human behavior and of the human impact on the planet. Despite its diverse, interdisciplinary nature, zooarchaeology has three common research themes: methodology; continuity and change in human societies; and biological relationships. These are the primary topics explored in this volume.

The animals emphasized include macrofaunal as well as some microfaunal organisms. The term "macrofauna" refers to large vertebrates and invertebrates. All vertebrate classes are included. These are mammals (Mammalia), birds (Aves), reptiles (Reptilia), amphibians (Amphibia), cartilaginous fishes (Chondrichthyes), and bony fishes (Osteichthyes). Invertebrates include primarily molluscs (Mollusca) and crustaceans (Crustacea). The term "microfauna" may refer to small members of these same classes, such as anchovies, or to small organisms, such as parasites and insects. The tissues reviewed include skeletal bone and teeth, mollusc shell, and exoskeleton (such as crab shell). Egg shell and keratinized tissue such as hair, skin, and feathers are not stressed here.

Our emphasis is on animals whose remains inform us about aspects of relationships between humans and their natural and social environments, especially site formation processes, subsistence strategies, and paleoenvironments. Among these animals, those that offer food, shelter, transport, fuel, tools, ornaments, clothing, and social identity receive particular attention. We also explore the material culture related to the procurement and husbandry of animals. Examples are primarily those illustrating modern human (*Homo sapiens sapiens*) uses of these animals. The time period is from the Pleistocene into the nineteenth century AD.

The geographic range is global. Although examples are drawn from many parts of the world, we make no effort to provide regional surveys of zooarchaeological developments. Smith's (1995) review of the emergence of agriculture throughout the world provides regional surveys of both plant and animal data. His volume is a good place to obtain an overview of current zooarchaeological knowledge in the context of broader archaeological research. Our intention is to review biological, ecological, and anthropological aspects of zooarchaeology from the wide variety of geographical settings in which zooarchaeology is practiced and to summarize broadly the diverse ways in which humans and animals interact.

The volume is organized in much the same way a faunal study might be. A knowledge of the history of zooarchaeology and current research topics provides the intellectual background a zooarchaeologist should bring to the study of a specific faunal assemblage (chapter 2). It is also important to be familiar with biological (chapter 3) and ecological principles (chapter 4) basic to the discipline. In chapters 5, 6, and 7, three sources of bias in a faunal assemblage are reviewed, beginning with taphonomy and excavation procedures. Chapters 6 and 7 present some of the most basic zooarchaeological methods, using a hypothetical archaeofaunal collection to illustrate fundamental methods for collecting primary and secondary data. In the remaining chapters animal remains are interpreted in terms of subsistence strategies (chapter 8), domestication (chapter 9), and human impact on the environment (chapter 10). The final chapter (chapter 11) draws these threads together and considers future directions in the field.

This volume is not intended to replace the many excellent biological references; works focused on single organisms or groups of organisms; methodological descriptions and reviews; regional archaeofaunal syntheses; or theoretical treatments. Extensive references are offered for each topic covered in the following pages. We urge readers to use these as guides to more detailed treatments of each subject. We hope by this means to excite students to pursue their own interests in this diverse field so that they may share with us many hours of stimulating puzzlement.

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1

ZOOARCHAEOLOGY

Introduction

Zooarchaeology refers to the study of animal remains from archaeological sites. The goal of zooarchaeology is to gain a better understanding of the relationship between humans and their environment, especially between humans and other animal populations. Zooarchaeology is characterized by its broad, interdisciplinary character; which makes it difficult to write a review that adequately covers all aspects of the field. This diversity may be traced to the application of many physical, biological, ecological, and anthropological concepts and methods to the study of animal remains throughout the world by scholars with a wide range of theoretical interests and training.

Zooarchaeology, an interdisciplinary field

Although animal remains, especially fossils, have intrigued the human mind for centuries, the first critical examinations of these remains were not conducted until the 1700s. Since then, zooarchaeologists have relied heavily on combinations of the natural and social sciences, history, and the humanities for concepts, methods, and explanations. Traditionally many studies focus on zoogeographical relationships, environmental evolution, and the impact of humans on the landscape from the perspective of animals. More recently, anthropological interests in nutrition, resource use, economies, and other aspects of human behavior have joined the field. All of these topics are encompassed within modern zooarchaeology.

Basic biological principles and topics are fundamental to zooarchaeology. Biological research includes exploration of extinctions and changes in zoogeographical distributions, morphological characteristics, population structure, the history of domestication, paleoenvironmental conditions, and ecological relationships of extant fauna using subfossil materials to provide historical perspective. Paleontologists explore these issues in deposits which pre-date modern humans. Many of these topics can be studied without reference to humans, though the human element is important (Weigelt 1989:62; Wintemberg 1919). Much archaeofaunal research continues to reflect biological interests, especially ecological ones.

The anthropological or historical orientation of archaeology is an important source of diversity in zooarchaeology. Many researchers practice archaeology as a subfield of anthropology and strive to achieve a holistic perspective on human behavior (Willey and Sabloff 1974:12–16). Anthropological archaeologists have studied the cultural aspects of archaeological deposits under a succession of theoretical perspectives on the human/environmental relationship, which also contributes to the diversity of the field (see chapter 2). In other scholastic traditions, archaeology is a separate discipline with strong ties to classics and history.

Another source of diversity in zooarchaeology lies in the themes that traditionally are associated with specific regions of the globe or specific time periods (see Figure 1.1). Much research in Eurasia and northern Africa focuses on domestic animals within developing agricultural systems during the last few millennia. Researching the evolution of hunting behavior among early members of the human family dominates zooarchaeology in much of sub-Saharan Africa. Post-Pleistocene migratory patterns and the processes of human immigration are major research areas in the Americas, Australia, and many Pacific islands. Research into the role of animals in the development of complex cultures is characteristic of yet other settings and other time periods.

Probably the greatest source of diversity in the field is the multidisciplinary background of zooarchaeologists themselves. Despite a long-running debate over whether zoologists or anthropologists (Chaplin 1965; Daly 1969; Reed 1978; Thomas 1969) should study animal remains from archaeological sites, in reality the person working with them may be trained in a number of fields. Zooarchaeologists may be anthropologists, paleontologists, archaeologists, biological anthropologists, zoologists, ecologists, veterinarians, agricultural scientists, geographers, or geologists. Each field brings to the study of animal remains different perspectives, methodologies, and research goals.

What's in a name?

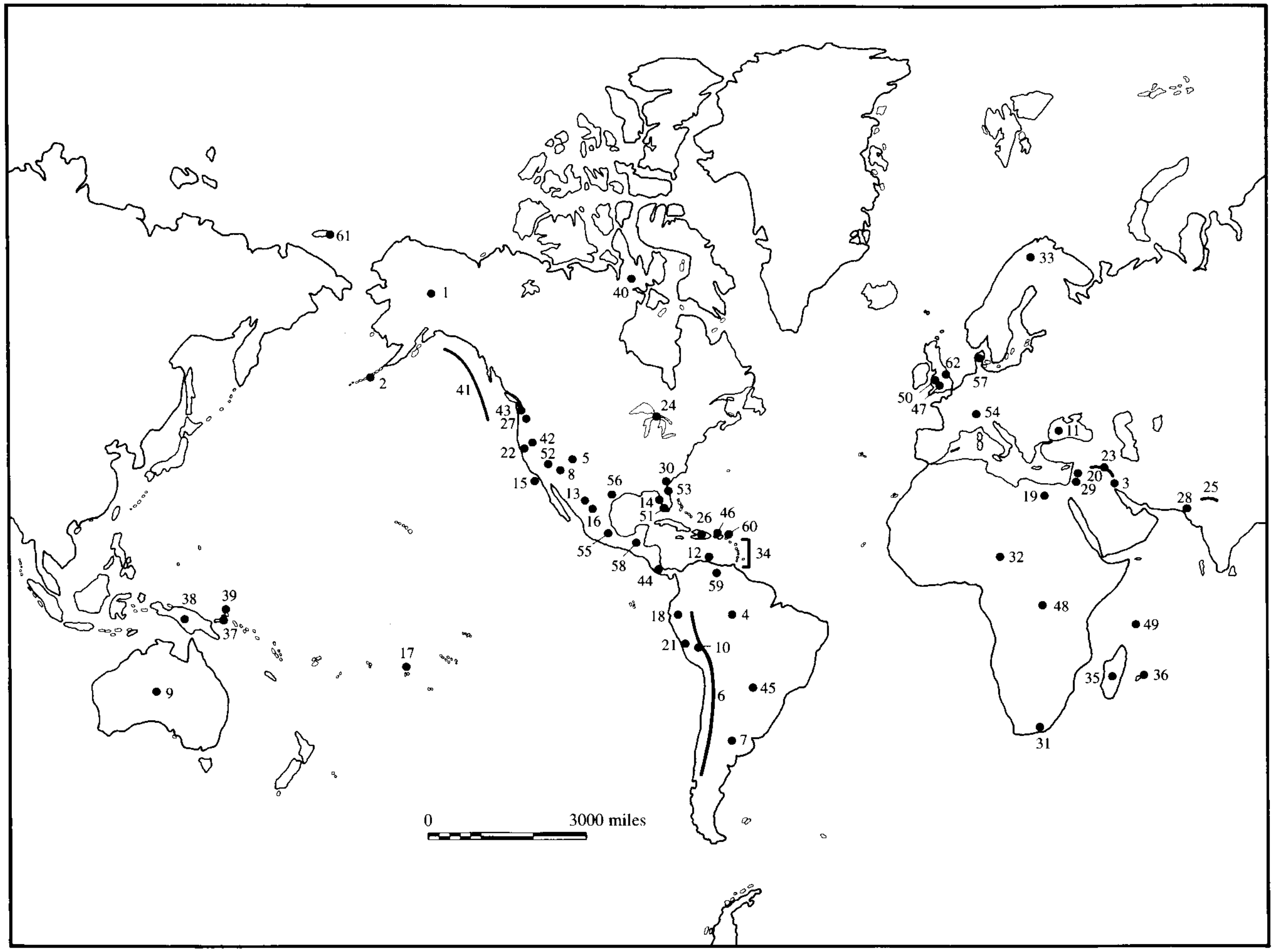
This combined biological and anthropological background is reflected in disagreements over the name for the field. One of the first clear references to the field was by Lubbock (Avebury 1865:169), who used the term "zoologico-archaeologist" to refer to Steenstrup and Rütimeyer, Europeans who studied animal remains from archaeological sites. These scholars and this term influenced American zooarchaeology through Morlot (1861) and Wyman (1868a), among others. For example, the Dutch term *kjøkkenmøddinger* (kitchen midden) appears in the title of one of Wyman's publications (1868a) and many nineteenth-century American studies refer to European research.

The modern derivatives, such as zooarchaeology, zooarchéologie, or zooarchaeología, are probably the most commonly used terms in the Americas and reflect the anthropological perspective of studying animal remains from archaeological sites in order to obtain information about human behavior (Bobrowsky 1982b; Hesse and Wapnish 1985:3; Olsen and Olsen 1981). Although Lyman (1982) proposes that "zooarchaeology" be confined to studies of paleoenvironmental conditions, the term more often implies a cultural perspective rather than a zoological or ecological one (Mengoni 1988). Many workers trained in the Americas do emphasize the cultural aspects of animal remains over zoological ones and prefer to call themselves zooarchaeologists.

The term "archaeozoology" is commonly used by researchers working in Eurasia and Africa, and emphasizes the biological nature of animal remains. Strictly interpreted, "archaeozoology" means "old zoology" or paleontology (Legge 1978). Although Bobrowsky (1982b) proposes that "archaeozoology" subsumes both zoological and archaeological interests, it may also be interpreted as the study of ancient animal remains without any relationship to human behavior (Hesse and Wapnish 1985:3; Olsen and Olsen 1981). The research of many people who prefer the term "archaeozoology" often is more biological than anthropological in nature. This name is widely recognized in the Americas both because many American faunal specialists work in Eurasia or Africa and because it appears in the title of the International Council of Archaeozoology (ICAZ).

Two other terms are occasionally used to describe the field: ethnozoology and osteoarchaeology. Ethnozoology may be defined as the study of human/animal relationships from the participant's (emic) rather than from the observer's (etic) viewpoint (Vayda and Rappaport 1968:489). Today it primarily refers to ethnographic studies of extant interactions between humans and animals; but in the past it included studies of archaeological materials (e.g., Baker 1941; Cleland 1966; Gilmore 1946). Uerpmann (1973:322) defines osteoarchaeology as the study of animal bones from archaeological sites for their contribution to cultural and economic history. "Osteo-archaeology" appears in the title of Reed's (1963) influential article; though he uses "zooarchaeology" in the text. Osteoarchaeology implies that only vertebrate bone is studied (Olsen and Olsen 1981), and hence studies of invertebrates or of vertebrate structures such as scales might not be included. Most faunal analysts consider both vertebrates and invertebrates important evidence of site formation processes, subsistence strategies, and environmental conditions, so few use osteoarchaeology except in reference to human osteology.

While the discussion over a name may seem trivial, and largely can be traced to the ways different languages handle compound words, it demonstrates that animal remains are sources of both biological and anthropological data (Bobrowsky 1982b; Chaplin 1965; Grayson 1979; Lawrence 1973; Lyman 1987; Ringrose 1993; Uerpmann 1973). In many ways the question of whether biological or anthropological issues should be emphasized reflects the variety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1.1 Locations mentioned in the text.

1 Alaska, USA; 2 Aleutians, Alaska, USA; 3 Ali Kosh, Iran; 4 Amazon Basin; 5 Anasazi, Colorado, USA; 6 Andes, western South America; 7 Argentina; 8 Arizona, USA; 9 Australia; 10 Ayacucho, Peru; 11 Black Sea; 12 Bonaire, Netherlands Antilles; 13 Casas Grandes, Chihuahua, Mexico; 14 Cedar Key, Florida, USA; 15 Channel Islands, California, USA; 16 Chihuahuan Desert, USA and Mexico; 17 Cook Islands, Polynesia; 18 Ecuador; 19 Egypt; 20 Ein Mallaha, Israel; 21 El Paraiso, Peru; 22 Emeryville, California, USA; 23 Fertile Crescent, southwest Asia; 24 Fort Michilimackinac, Michigan, USA; 25 Himalayas; 26 Hispaniola, Greater Antilles, Caribbean; 27 Hoko River, Washington, USA; 28 Indus Valley, Pakistan; 29 Jericho; 30 Kings Bay, Georgia, USA; 31 Klasies River mouth, South Africa; 32 Lake Chad, northern Africa; 33 Lapland; 34 Lesser Antilles, Caribbean; 35 Madagascar; 36 Mauritius, Indian Ocean; 37 New Britain, Melanesia; 38 New Guinea; 39 New Ireland, Melanesia; 40 northern Canada; 41 northwest coast, North America; 42 Old Sacramento, California, USA; 43 Ozette Village, Washington, USA; 44 Panama; 45 Paraguay; 46 Puerto Rico; 47 Salisbury Plain, England; 48 Semliki Valley, Zaire; 49 Seychelles, Indian Ocean; 50 Somerset Levels, England; 51 southwest Florida, USA; 52 southwestern United States; 53 St. Augustine, Florida, USA; 54 Swiss Lake sites, Switzerland; 55 Teotihuacan, Mexico; 56 Texas, USA; 57 Troldebjerg, Denmark; 58 Uaxactun, Guatemala; 59 Venezuela; 60 Virgin Islands; 61 Wrangel Island, Russia; 62 York, England.

of roles played by animals in human lives and the diversity of information provided by animal remains from archaeological sites, not all of which are pursued by every researcher. Depending upon the specialist's training and interests, the nature of the archaeological deposit, and the research objectives of the project, faunal analysis may include all vertebrate and/or invertebrate classes, or focus only on one taxonomic group. Hair, horn, feathers, hide, scales, feces, blood residue, DNA, isotopes, trace elements, insects, mites, or egg shell recovered from archaeological contexts may be central to a faunal study, occasionally examined, or ignored altogether. Using animal remains one may explore bioturbation, nutrition within a specific subsistence strategy, settlement patterns, ethnicity, the socioeconomic parameters of meat exchange, domestication, faunal successions, or population characteristics of animals responding to predation. These differences are reflected in the various names applied to the field. Many people who work with animal remains from archaeological sites avoid the issue by referring to their studies as faunal analysis (Smith 1976) or animal bone archaeology (Hesse and Wapnish 1985).

In essence zooarchaeology and archaeozoology are alternate ways to view the same materials. It is not so much that biology, archaeology, anthropology, history, or humanities dominates a study, but rather that they be combined. An anthropological analysis of animal remains begins with a sound biological foundation, but we must always be aware of the human context of the materials we study. Hence, "zooarchaeology" is used throughout this volume. The field is strengthened by the diverse interests we subsume under this name, including some which are traditionally viewed as biological or ecological. Most faunal analysts do not find these perspectives mutually exclusive. They recognize that humans respond to the same biological requirements governing the behavior of other organisms and that these responses influence cultural institutions. Humans also alter the world around them, as do other organisms. At the same time, faunal assemblages reflect cultural systems, from economic institutions to ideology. These must not be exclusive research perspectives (e.g., O'Connor 1996). The integration of all facets of animal remains enlivens the field and is essential for its continued intellectual health.

The biology/anthropology issue has another facet which impacts the relationship between zooarchaeology and archaeology. While zooarchaeologists recognized long ago that animal remains in archaeological sites are artifacts which passed through the "cultural filter" (Daly 1969; Legge 1978; Reed 1963:210; Uerpmann 1973), some archaeologists distinguish between "artifacts," which are modified by humans, and "ecofacts," which are culturally relevant non-artifactual materials (Binford 1964; Shackley 1981:1). To separate the consequences of human behavior from natural phenomena, it is critical that the *artifactual* nature, the cultural context, of animal remains be appreciated (Daly 1969; Legge 1978). Biologists and paleontologists recognized the artifactual nature of unmodified as well as modified animal remains in archaeological contexts more quickly than did archaeologists (e.g., Weigelt 1989). Some animals are considered inedible and others are important as sacrifices but would never be eaten or their remains used to make ordinary tools. In some cases, these classifications have little to do with the local abundance of the resource or its nutritional value, though they may have an ecological basis (Harris 1974). Even those animals present in a faunal assemblage without human intent reflect human behavior because hedgerows, attics, trash heaps, and gardens are important animal habitats. The animals for whom human behaviors unintentionally create such habitats offer a wealth of information about the built environment; though their usefulness as a source of information about the "natural" environment may be limited.

The interaction of humans and animals: the many uses of animals

The primary purpose of zooarchaeological research is to learn about the interactions of humans and animals and the consequences of this relationship for both humans and their environment. Most animal remains are the result of complex human and non-human behaviors with resources in the environment, cultural perceptions of those resources, and the technological repertoire used to exploit them. Exploration of change in human societies is one of the most common areas of zooarchaeological research; but many geological, biological, and historical factors may be responsible for such changes. On the other hand, stasis is a common feature in the zooarchaeological record. Explaining cultural change and continuity is complicated by those interactions and it is important to consider the many uses of animals and the diverse paths over which animal remains travel to become part of the archaeological record. This is what Reed (1963) meant by the cultural filter. Zooarchaeologists may find evidence of these uses hard to define, but doing so is an important component of zooarchaeological research.

One of the most fundamental uses of animals is for nutrition. Nutritional uses of plants and animals form the basis of subsistence strategies and eventually of economic and other cultural institutions. Associating animal remains recovered from archaeological sites with nutrition is one of the primary goals of many zooarchaeologists. Some of these uses leave ambiguous archaeological evidence. For example, traded salt fish may leave little evidence for fish consumption at the recipient end of the trade network, as might the purchase of meats from markets. Many tissues other than muscle, such as viscera, brains, and eggs, can be used for food but leave little evidence of their use. Antlers, often interpreted in terms of tools or ornaments, are ingested for medicinal purposes in many parts of the world today. Ethnographic observations as well as coprolites (paleofeces) indicate that what is edible, and what is not, cannot be assumed (Price 1985; Sobolik 1993; Szuter 1988, 1994; Weir *et al*. 1988).

Much of an animal's carcass may be used for non-nutritional purposes. Wool, hair, and hide may provide clothing, shelter, carrying devices, or cordage. They may be used to construct watercraft, traps, or other tools. Some elements may be used as tools after their food value is depleted and others, such as a clam shell, may be more highly valued as raw material for tools and ornaments than as food. Oils, fats, gelatin, and glue are other important animal by-products, but the activities related to extracting them may be difficult to distinguish from other processes (Schmid 1972:46–9). Animals also contribute manure, which may be used as fuel, building material, or fertilizer. Many of these uses leave little or no evidence in the faunal record. They are, however, important in the relationships between humans and the environment as well as in the formation of the archaeofaunal record.

Domestic animals are widely used as work animals. Their labor is important in trade and tilling fields. Animals sometimes serve guard duty. We tend to think of dogs (*Canis familiaris*) in this role, but birds such as the double-striped thick-knee (*Burhinus bistriatus*; Reitz and Cumbaa 1983; Thomson 1964:816) and geese (e.g., *Anser anser*) alert as well. Animals are also used for hunting (dogs), gathering truffles (pigs [*Sus scrofa*]), and fishing (cormorants [Phalacrocoracidae]). Animals may be so valuable in these roles that they are not slaughtered until they are very old, if at all, and their remains may not be discarded in locations commonly excavated by archaeologists (e.g., Payne 1972a).

Animals are used to signify many cultural attributes including social affiliation and belief systems. Symbolic associations may either mean an animal is represented in a faunal assemblage for non-nutritional and non-technological reasons, or mean the animal is absent from the faunal assemblage even though it was culturally important. Many people have pets for emotional support (Gade 1977; Redford and Robinson 1991; Serpell 1986, 1989). The animal, parts of the animal, or images of the animal may be kept so that the individual, household, or community will be associated with its special powers. Bones from a rabbit's foot (Lagomorpha) could be skinning refuse, but they might also be from a charm. Many ceremonies use animals to express social organization and values symbolically.

Requirements for the study of animal remains

The study of animal remains from archaeological sites requires a sound biological foundation without which any faunal study will be at best incomplete and at worst inaccurate. Such knowledge begins with basic biological and ecological concepts. This includes skeletal biology and morphology of tissues such as teeth, bone, shell, and crustacean exoskeleton usually recovered from archaeological sites. Taxonomic classifications such as those in Table A1.1 are not static; hence it is necessary to know current systematic classifications and the basis for those classifications. It is also important to be familiar with animal behavior and ecology, especially with those concepts related to predator–prey relationships, biogeography, ecosystems, population ecology, and the habits and habitats of the animals with which humans interact (Tchernov 1992a).

Components of a study

Inadequate attention to the biological component of the archaeofaunal record hampers interpretation of such data in terms of human behavior. All zooarchaeologists can cite cases where inattention to biological details undermined a conclusion. For example, failure to know the zoogeographic history of Old World rats (*Rattus norvegicus* and *R. rattus*) may mean the significance of an Old World rat identified in an archaeological sample deposited in the Americas prior to European colonization will go unrecognized. Our current understanding is that Old World rat species were introduced into the Americas by European expansion (Armitage 1993); hence, an Old World rat in the Americas means the archaeological context was deposited after AD 1492, the rat was in an intrusive context, or the identification is incorrect.

Consideration of first- and second-order changes such as site formation processes and excavation procedures is equally important for an adequate interpretation of an archaeofaunal assemblage. The taphonomic history of a site may introduce or remove animal remains and is an important contributor to the final character of archaeofaunal deposits. Human disposal patterns, the function and structure of the site, and archaeological techniques all impact faunal composition.

Laboratory methods are also important. The complexity of the relationship between humans and their environments requires pursuit of numerous lines of inquiry using techniques that do not mask or skew the evidence and that are appropriate to the research questions. Many zooarchaeological techniques originate in biology and paleontology. Additional techniques develop as the need arises and are then applied in other situations. All have strengths and weaknesses that should be considered before they are applied to faunal studies.

After assessing the history of the assemblage and recording the biological data, researchers interpret the results using information from many sources. This is especially true when data could be subject to several interpretations. Support for each hypothesis should be derived from several lines of evidence. This includes multiple faunal data sets, but also ethnographic analogy, modern experimental studies, and the cultural contexts of the materials. Ethnographic analogy is widely used in archaeology to broaden our horizons about ways humans and animals interact and the consequences of those behaviors (Hudson 1993; Wylie 1985; Yellen 1977a:4–5). Experimental and ethnoarchaeological studies also contribute to our understanding of depositional, spatial, temporal, and social factors that might impact archaeological deposits (Brain 1981; Gifford-Gonzalez 1989; Kroll and Price 1991). The cultural context of an assemblage is critical in the interpretation of archaeological data because activities involving animals are quite different depending upon whether the context excavated is a temple, midden, house, storage structure, or kill site. Cultural institutions also are involved in storage, resource control and exchange, warfare, wealth, kinship, and ritual aspects of animals. Additional information may come from petroglyphs, figurines, murals, written records, or other archaeological artifacts.

Terminology

Zooarchaeologists use a great many names and abbreviations (Casteel and Grayson 1977; Lyman 1994a). This large nomenclature creates confusion that we will attempt not to augment; but some terms do need to be defined at this point. In the following presentation, a specimen is an isolated bone, tooth, or shell (Lyman 1994b; Shotwell 1958). The term "element" refers to a single complete bone, tooth, or shell and "specimen" to either a complete bone, tooth, or shell or a portion thereof. If a specimen is complete it is an element, and if it is broken it is a fragment of an element. This same concept may be extended to include complete or broken mollusc valves and crustacean carapaces. Elements are rarely found in archaeofaunal samples; fragmentary specimens constitute most of an archaeofaunal sample. Samples contain multiple faunal specimens of various taxa that presumably had some relationship before excavation began. A sample is contained within an individual collection container from a unique archaeological provenience or context identified and segregated in the field. All samples from a single time period from a single site comprise a collection. Many sites have multiple occupations of different time periods. These represent an assemblage.

Systematic relationships are valuable tools in communicating clearly which species or other taxonomic levels are under discussion. Scientific names, as well as their related common or vernacular names, are usually used by zooarchaeologists with precise meanings in mind. By following a standard systematic scheme, most zooarchaeologists understand what their colleagues mean in their choice of scientific and common names. Domesticated members of the family Bovidae, however, are an exception to this because common English terms are not directly related to taxonomy. Strictly speaking, only female members of the species *Bos indicus* and *Bos taurus* should be called cows, though this term is often used to refer to male bulls and castrated steers as well. On the other hand, the term "cattle" is often used to encompass all domestic members of this family, including neat cattle such as goats (*Capra hircus*) and sheep (*Ovis aries*). In the following pages, we will use the term cattle to refer only to *Bos taurus*. When other members of this family are meant, other terms will be used.

Conclusions

Zooarchaeologists today explore many exciting arenas. One of these is the use of resources by human populations and the common threads that run through the diverse adaptations made to different environments. Another is the integration of plant, animal, human, and geological evidence into a holistic understanding of the human past. Others explore the use of animals in tools, ornaments, and rituals. Biological research, especially that focusing on the evolutionary history of landscapes and animal populations, involves many zooarchaeologists. In the following chapters we introduce the concepts upon which such studies are based, the biological basis for zooarchaeological procedures and interpretations, and the methods by which these are applied to animal remains from archaeological sites, and survey some of the interpretations which may be obtained.