Animal Bones and Archeological Inference

Bones. Ancient Men and Modern Myths. LEWIS R. BINFORD. Academic Press, New York, 1981. xxviii, 322 pp., illus. $36.50. Studies in Archaeology.

Bone assemblages from archeological sites have long been regarded as key evidence concerning past human diet and subsistence activities. Taphonomic research during the past decade has certainly increased our awareness that many complex processes may affect bone preservation between the time of an animal's death and the fossilization of its bones, and this has sharpened our ability to link specific processes with their material traces in ancient bone assemblages. In *Bones: Ancient Men and Modern Myths*, Lewis Binford's major premise is that many archeologists have tended to overlook other explanations of their bone data in favor of interpretations involving human behavior. Binford argues that this has resulted in many modern myths about past human exploitation of animal resources, and the book focuses on developing a methodological framework for correcting this problem.

In a characteristically provocative manner, Binford begins his imposing task with a hard-hitting historical account that traces key assumptions about bone and artifact associations implicit in earlier archeological studies. His path of devastation leads to every continent that has archeological sites, except Australia, and back through time to the Early Pleistocene. He examines previous interpretations of North American bison butchery sites, Torralba, Choukoutien, Koobi Fora, Olduvai Gorge, and many other sites. Binford argues that carnivorous predator-scavengers played a larger role in modifying and accumulating bone assemblages than many archeological interpretations indicate.

Reading Binford's historical summary may elevate some blood pressures, but this should be amply offset by the fascinating way in which he traces the development in archeologists' attitudes about bone and artifact associations. His historical summary should be recognized as rather selective. Authors of some of the best-known 19th-century insights into bone-related processes are barely mentioned (Lartet and Christy, 1875) or entirely overlooked (Lubbock, 1865). Binford pulls few punches in dealing with more recent researchers. Dart is repeatedly quoted, even though over a decade ago Brain's work enabled most scientists to dismiss the osteodontokeratic hypothesis Dart proposed. Bonnichsen and Morlan are handled in an unbalanced manner for their work on bone fracture; in attempting to dispel the alleged myth of early human entrance into North America, Binford fails to mention Morlan's high-quality photographs of cut marks on bones from Old Crow Flats (*Archaeological Survey of Canada Paper No. 94* [1980]). Likewise, Binford's reference to Isaac's most informal, popularized writings and his categorization of Isaac's hypotheses as premature and wildly inaccurate obscure Isaac's pioneering and continuing advocacy of taphonomic research on both human and nonhuman processes affecting bone and artifact accumulations.

Though some of Binford's comments are overly harsh and unfair, his general point that unwarranted assumptions have generated many modern archeological myths is valid and timely, because both textbooks and technical papers continue to treat bone and artifact associations without due regard for the complexity of possible explanations. The persistence of mythmaking through what Binford calls post hoc accommodative models illustrates the importance of his vehement demands for more science in archeological research.

In part 2, Binford turns to the development of a sound methodological approach. These chapters are the longest and most important part of the book. Binford argues convincingly that what he terms middle-range research is vital for providing a frame of reference for scientifically justifiable interpretations of archeological data. Through actualistic, pattern-recognition studies of observable bone-modifying processes and their material consequences, one can develop diagnostic criteria for relating static archeological data to specific dynamic processes that operated in the past. In Binford's words, this strategy "will yield results never dreamed of by contemporary . . . archaeologists."

Binford presents a wealth of impressively detailed data on modern human processing of animal carcasses, summarized from his earlier book on bones, *Nunamiut Ethnoarchaeology* (Academic Press, 1978), and on modification of bones by predator-scavengers (primarily wolf and domestic dog). Various types of tool-induced butchery marks and tooth-induced gnaw marks and breakage patterns have been described before, but Binford makes a major contribution by very effectively linking variations in surficial modifications and aspects of assemblage composition to particular behavioral contexts. Through multivariate statistical analysis of the modern human and carnivore data, he then develops diagnostic criteria for distinguishing the differently derived bone assemblages.

The book might well have ended here with a discussion of other processes that deserve similar middle-range research, so that diagnostic criteria representing a range of critical bone-related processes could be employed in the interpretation of archeological bone assemblages. Binford does not take this easy option; instead, in part 3 he chooses to apply his diagnostic criteria in an analysis of Early Pleistocene bone assemblages from Olduvai Gorge. Binford conducts another factor analysis using his data on canid predator-scavengers in an attempt to demonstrate that most of the assemblages result from nonhominid predator-scavenger behavior, either as transported accumulations at carnivore dens or as residual scatters at carnivore kill sites. The FLK *Zinjanthropus* site is interpreted as a nonhominid carnivore kill site, at which hominids collected already dismembered skeletal parts for the purpose of marrow extraction. Binford repeatedly expresses confidence in these analytical results, with qualifying disclaimers carrying the impact of fine-print apologies for mistaken front-page newspaper headlines.

Because of a variety of weaknesses in Binford's analysis it is doubtful that his results on Olduvai are a useful contribution to scientific archeology. For his reevaluation of Olduvai Binford relies on the data on bones that Mary Leakey published, with the statement (p. 248) that they "should be regarded as a preliminary report," in volume 3 of *Olduvai Gorge* (Cambridge University Press, 1971). In that report Leakey did not attempt to estimate minimum numbers of individuals (MNI), because taxonomic work was incomplete at the time. Binford makes his own conversion of her data to derive MNI estimates, despite their clearly indicated incompleteness. He does not cite a more recent paleontological monograph by Gentry and Gentry (*Bulletin of the British Museum of Natu-*

ral History, vol. 29, no. 4, and vol. 30, no. 1 [1978]), which, though its estimates are based on the more complete specimens rather than on entire assemblages, gives MNI estimates for Olduvai bovids. Nor apparently did he consult a thorough review by Isaac and Crader (written in 1977 and widely circulated; published in 1981 in *Omnivorous Primates*, R. Harding and G. Teleki, Eds., Columbia University Press) of published reports on Early Pleistocene African bone assemblages and their implications for hominid carnivory. Isaac and Crader reach many comparable conclusions (for example, they reject vertically diffuse accumulations as representing living floors) without MNI estimates or the numerical acrobatics conducted by Binford.

Many of the methods by which Binford converted Mary Leakey's data for analysis involve highly risky assumptions, and errors of great magnitude are consequently inherent in his results. For example, for the famous FLK *Zinj* site Binford calculates an MNI estimate of 13.07, based on teeth. He then calculates MNI estimates for other skeletal parts at FLK *Zinj* and other Olduvai sites and uses these as fact. The dangers of error in such a superstructure will be well understood from the fact that my own recently completed archeological analysis of the bones making up the FLK *Zinj* assemblage yields an MNI estimate, based on teeth, of 40 individual animals identifiable as bovid, suid, equid, and giraffid. Many more identifiable bone specimens are present than Binford's numbers indicate. Moreover, the presence in the FLK *Zinj* assemblage of numerous cut-marked bones that are identifiable to skeletal part (H. T. Bunn, *Nature (London)* **291**, 574 [1981]; R. Potts and P. Shipman, *ibid.*, p. 577) indicates, on Binford's criteria, that skinning, dismemberment, and meat removal by hominids occurred. These facts strongly suggest bone accumulation principally by hominids, followed by carnivore scavenging, as the simplest interpretation of that site.

Binford raises the important question of natural background bone density resulting from normal animal mortality and other nonhominid factors, but he does not develop this line of reasoning adequately, even though it is critically important to interpretations of bone and artifact accumulations as indicating living floors and home bases. He makes some astute comments on the alleged hippo and elephant butchery sites at Koobi Fora and Olduvai. With justification he challenges the interpretation of these sites as representing butchery of large mammals by early hominids, arguing that some or all of the bones present may be part of a natural scatter. At many of the Olduvai and Koobi Fora sites the bone densities that Binford chooses to regard as background density do, however, stand out as strong high-density anomalies relative to the modern East African background bone-density figures of Hill and Behrensmeyer (*Fossils in the Making*, University of Chicago Press, 1980). That contrast does not support Binford's position, unless it can be assumed that the alleged background accumulations took place over a long period of time (or at a faster rate than is documented in modern analogue environments). In view of Mary Leakey's reports of fresh, unweathered, unabraded bones and artifacts and Hay's statements concerning depositional conditions (*Geology of the Olduvai Gorge*, University of California Press, 1976), such assumptions seem improbable to say the least. Though it is true that anomalously high bone densities either with or without stone artifacts in physical association do not in themselves necessarily indicate hominid involvement, recognizing that the sites are high-density anomalies does permit a fairer understanding of Mary Leakey's reasons for viewing the bones as hominid food debris.

There are also problems with Binford's use of data derived from modern carnivores. One of these has to do with the transferring of diagnostic criteria on bone fragmentation from modern human and carnivore assemblages to the Early Pleistocene. The problem is not that uniformitarian assumptions about these properties are unwarranted; rather, premature application overlooks other potential agents of bone fragmentation, including fragmentation resulting from trampling of exposed bones by large mammals. This process may operate in a manner that is analogous to attrition from animal gnawing, which Binford emphasizes may cause initially different bone assemblages to appear more similar. Moreover, for his generalizations Binford, though he uses some African data, relies principally on his own relatively small set of data on Alaskan wolves. In so doing, he implicitly equates wolves with hyenas and other large African predator-scavengers. Yet, as Binford documents, wolves are at the top of the carnivore hierarchy and can afford to lounge around and sleep beside partially eaten carcasses. African hyenas often do not share that luxury, and faced with more competition hyenas exhibit considerable behavioral variability both within and between species. Ongoing research has shown that hyenas are capable of a broad spectrum of bone transport and modification. In mechanical terms, spotted hyenas are probably stronger than wolves as bone breakers and thus are probably capable of considerably more bone destruction.

Still another weakness of Binford's analysis is that in viewing sequentially modified assemblages first in terms of canid predator-scavenger data and attributing only residual variations to other factors without considering alternative lines of analysis and explanation he is guilty of the same type of single-mindedness for which he relentlessly criticizes others. Why should the opposite sequence—hominids as principal agents of bone transport and modification, followed by attrition due to scavenging carnivores—escape Binford's serious consideration?

Binford's presentation is marred by many unnecessary errors, including mislabeled or incompletely labeled graphs and tables, erroneous text references to his own and other researcher's tables, and misquotation of other researchers' published and even unpublished writing. Patient detective work can resolve most of these discrepancies, but that is asking a lot of the reader.

Binford's book will have a major impact on future archeological research by stimulating additional middle-range research. Despite what I consider to be serious shortcomings, the book is essential reading for archeologists and others with an interest in past human subsistence activities, but it should be read with the full understanding that some of the modern myths are being generated by Binford.

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Endosymbiosis vs. Autogeny

Origins and Evolution of Eukaryotic Intracellular Organelles. Papers from a conference, Jan. 1980. JEROME F. FREDERICK, Ed. New York Academy of Sciences, New York, 1981. x, 512 pp., illus. Cloth or paper, $99. Annals of the New York Academy of Sciences, vol. 361.

The further back in time we attempt to trace phylogenies the less reliable is the evidence and the more conjectural are the conclusions. Facts become especially hard to find, and hypotheses are correspondingly easy to make, when we ask about the origin of eukaryotes (animals, plants, fungi, protists) and their distinc-