AN ACTUALISTIC BUTCHERY STUDY IN SOUTH AFRICA AND ITS IMPLICATIONS FOR RECONSTRUCTING HOMINID STRATEGIES OF CARCASS ACQUISITION AND BUTCHERY IN THE UPPER PLEISTOCENE AND PLIO-PLEISTOCENE

(Volume 1)

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Thesis Presented for the Degree of DOCTOR OF PHILOSOPHY in the Department of Archaeology UNIVERSITY OF CAPE TOWN

April 2000
this dissertation is dedicated to my mother

Shirley Jean Nilssen

and to the memory of my late father

Nils-Gunnar Nilssen
ABSTRACT

Author: Peter John Nilssen. Dissertation Title: An actualistic butchery study in South Africa and its implications for reconstructing hominid strategies of carcass acquisition and butchery in the Upper Pleistocene and Plio-Pleistocene. Date: April 2000

Evaluating inferences about hominid meat-eating behaviours is the primary objective of this study. Many scholars consider these behaviours as critical features in human evolution. Most zooarchaeologists agree that butchery marks constitute the most reliable gauge of hominid involvement with animal bones. I focus on cut marks because the actualistic study performed at Merriman (MRM) focused on cut mark placement and frequencies produced by different butchery activities.

Many reconstructions of hominid meat-eating behaviours were based on Binford’s ethnographic observations of the Nunamiut. The primary shortcoming of this and other actualistic butchery studies is that cut marks produced by different butchery activities were not separable into categories related to specific butchery activities, because several butchery procedures were performed on the same bones. The present study remedies this situation by separating butchery activities so that cut marks could unambiguously be assigned to specific butchery procedures. An additional shortcoming with previous actualistic butchery research is that cut mark frequencies were not commonly presented, primarily because different butchery procedures were indistinguishable. This dilemma is partially resolved by the MRM study. Numerous cut marks attributed to dismemberment by Binford are proved dubious through the MRM study and a revised inventory of cut marks and their associated behaviours is presented. The MRM observations are not offered as the ‘fingerprint directory’ for cut marks. Rather, the MRM observations should be viewed as well-founded guidelines that require testing and/or substantiation through additional actualistic research.

The MRM results are compared with data from two important archaeological sites. Comparisons reveal that Upper Pleistocene hominids processed animal carcasses similarly to butchers at MRM. Hominid access to carcasses of large bovids, however, was not complete and I suggest that carcass parts were acquired through aggressive, confrontational scavenging. On the contrary, Plio-Pleistocene hominids were acquiring and butchering carcasses differently from butchers at MRM and at the Upper Pleistocene site. Apparently, early hominids were not acquiring early access to small or large animals, but were obtaining certain carcass parts before they were entirely cleaned of soft tissues by marginal scavengers.
ACKNOWLEDGEMENTS

John Parkington maintained his commendable aptitude to stay tuned through numerous changes in the format and content of this dissertation. I am dearly grateful for John’s unwavering support and guidance as supervisor and mentor for this study. John’s charisma and enthusiasm for archaeology was the bait that lured me into the discipline in the first place. Special thanks go to you John.

I am very grateful to Teddy Kuttel for giving me paternal advice when sorely needed. I thank the staff of the South African Museum for access to laboratory and office space as well as equipment and the kettle. In particular, I thank Graham Avery for his backing and encouragement throughout this project, and for valuable comments during discussions. Curtis Marean helped in countless ways over the last few years and I am especially grateful for all his encouragement, assistance and guidance. I thank Sarah Winter for assisting during the fieldwork phase of the research. Many people were very helpful during fieldwork in the Karoo and I specifically thank Rick, Sue, Adam, Vygie, Harry, Bridget, John, Lorette, Greg, Luke, Peter, Herman, Bettie, Freek, Douw, Fanie and Julian. I am very grateful to Yoshiko Abe for digitizing the cut marks recorded on the comparative assemblage, for many hours of constructive discussions and for endless supplies of smiles. I am greatly indebted to Jason and John Orton for allowing me to use their computer for much longer than anticipated I also thank Rene Navarro for his help with statistical tests. Many thanks to Dave Halkett and Tim Hart for employing me in CRM projects. This was my financial source over the last few years. As with most graduate projects in archaeology at UCT, Royden Yates helped in numerous ways during this work and provided valuable comments during discussions. I also thank Royden for helping with computing problems as well as the line drawings of the skeletal silhouettes. No archaeology graduate student leaves UCT without considerable assistance from John Lanham. In his customarily relaxed and generous style, John helped me with computing problems on numerous occasions and I am greatly indebted to him. I am grateful to Richard Milo for providing cut mark information for the Klasies River assemblage. Various discussions with friends and colleagues guided this dissertation and I do not name them all here in fear of omitting anyone, but I thank all who were involved. A special thanks is due to Tony, John and James for allowing me to unwind by way of strings and frets.
I thank Antonieta Jerardino for being there through it all; words cannot relate the enormity of my gratitude to her. Most importantly, I thank my family and especially my mother, Shirley, for her unwavering love, encouragement and support.

For financial assistance I wish to thank the Spatial Archaeology Research Unit (University of Cape Town), the Department of Archaeology (University of Cape Town), the Harry Oppenheimer Institute for African Studies, and the University of Cape Town Research Committee. The financial assistance of the Centre for Science Development (HSRC, South Africa, now the NRF: DSSH) and the Foundation for Research Development (FRD, South Africa, now the NRF) towards this research is hereby acknowledged. Opinions expressed in this work, or conclusions arrived at, are those of the author and are not to be attributed to the Centre for Science Development or the Foundation for Research Development.
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CHAPTER 1

AN INTRODUCTION TO BUTCHERY STUDIES IN ARCHAEOLOGY

1.1. INTRODUCTION

The status of butchery studies and particularly actualistic research into this topic in the early 1990’s was the catalyst for research conducted at Merriman (MRM) and reported here. In the early 1990’s I conducted a pilot study of the literature on butchery, and a microscopic examination of surface modifications on eland bones from the site of Dunefield Midden on the western Cape coast (Cruz-Uribe & Klein 1994; Nilssen 1989; Parkington et al. 1992). My findings indicated the urgency for additional, detailed, and problem-oriented actualistic research into butchery and its material expression in the form of damage to bone surfaces. In many rural parts of South Africa, farmers cull game annually and commonly process animals for the production of biltong (dried meat) and sausage. Having grown up in the Karoo, I contacted a friend involved in professional hunting with a view to conduct a pilot study to establish the type of information that could be gleaned from observing seasoned butchers in a modern, non-ethnographic context. The pilot study revealed an ideal situation for obtaining information concerning the processing of animal carcasses. During the culling season of 1993 I observed, filmed and recorded several aspects of butchery at MRM, situated roughly in the centre of South Africa. The results from actualistic butchery studies at MRM comprise the backbone of this dissertation.

I begin with a brief discussion outlining the importance of butchery studies in archaeology in section 1.2. In section 1.3 I present a general overview of butchery studies in archaeology, and end this section by stressing the importance of actualistic research for interpreting faunal remains from archaeological sites. I discuss the nature and development of actualistic butchery studies and situate the MRM study in this undertaking in more detail in chapter 2. In section 1.4 I complete this chapter with a broad description of the contents of subsequent chapters of this dissertation.
1.2. THE IMPORTANCE OF MEAT EATING AND ITS ASSOCIATED BEHAVIOURS

The significance of carcass acquisition, butchery and meat eating in the ambit of human evolution is well described and summarised by Milo (1994 and references therein). Archaeological and palaeoanthropological studies into these topics are collectively referred to here as butchery studies. Dietary studies based on isotopic or similar assays, although of great value, are not considered here.

Archaeologists have been concerned with reconstructing the dietary behaviour of humans from animal bones recovered from archaeological sites for about 140 years (for history and references see e.g., Binford 1981; Lyman 1987a, 1994b). In this quest, researchers have focused primarily on the remains of animal foods because bones generally survive taphonomic processes better than the remains of vegetable foods. This bias in preservation is particularly acute at open Plio-Pleistocene sites such as Koobi Fora and Olduvai Gorge. Moreover, meat eating and its accompanying behaviours are considered by certain scholars to be a critical variable in the behavioural and perhaps physical evolution of hominids (e.g., Ambrose 1986; Gamble 1979; Isaac 1978; McHenry & O'Brien 1986; Potts 1984a; Speth 1989; Turner 1992; Washburn & Lancaster 1968). This perspective, however, has been questioned and challenged by several authors (e.g., Conkey & Gero 1991; Dahlberg 1981; Fedigan 1986; Hawkes et al. 1988; Tanner 1981; Tanner & Zihlman 1976; Zihlman 1978).

The position taken in the current study is that meat eating and its associated behaviours are important because bones are more commonly preserved and more readily retrieved from archaeological sites relative to vegetable remains. Consequently, reconstructions of dietary behaviours are more commonly based on faunal rather than vegetable remains. Nevertheless, as some of the authors listed above have argued, vegetable foods are the staple diet of most modern hunter-gatherers.

The large number of publications, cited in subsequent chapters, that center on discussions about carcass acquisition, butchery and meat eating, attest to the importance of this topic in studies related to the evolution of hominids and the appearance of behaviourally modern people. Additionally, and along with other behaviours, “among living humans the acquisition, sharing and consumption of meat are matters of great personal, social and symbolic significance (Bicchieri 1972; Clark 1972; Coon 1971; Lee & DeVore 1968; Ortega y Gasset 1972)” (Milo 1994: 13).
1.3. AN OVERVIEW OF BUTCHERY STUDIES IN ARCHAEOLOGY

Lyman (1987a) provides a thorough evaluation and review of butchery studies in archaeology as evidenced in the literature up to the middle of 1985. Since Lyman’s review, numerous books, series and papers continue to be published on the topic of butchery, but a similar appraisal and review of the literature has not been published recently. This is partly attributable to the very large number of publications on the topic over the last 15 years, which in itself signifies the importance of butchery studies in archaeology and palaeoanthropology. I do not attempt to summarize the vast literature on butchery studies here, but focus instead on issues that relate directly to this dissertation. Although butchery studies have been conducted on faunal remains from a variety of archaeological sites, spanning roughly the entire period of human history, I am particularly concerned with butchery studies pertaining to Upper Pleistocene and Plio-Pleistocene faunal assemblages in Africa. More specifically, because this dissertation is founded on actualistic research, I focus on the use of actualistic studies (ethnoarchaeology and experimental butchery) for developing models to interpret butchery marked bones from archaeological sites, and the application of such models for interpreting hominid dietary behaviour. I concentrate on methods for interpreting cut marks on animal bones, because the core of this study is concerned with cut marks and their behavioural correlates as developed through actualistic butchery at MRM. In chapters 5 and 6 I present the implications of the MRM study for reconstructing butchery and carcass acquisition strategies practiced by Upper Pleistocene and Plio-Pleistocene hominids.

Before the late 1970’s, archaeologists concerned with butchery focused on reconstructing human and hominid behaviour without detailed consideration of the complexities of taphonomic processes. In North America, for example, reconstruction of butchery strategies was initiated by Theodore White, whose interpretations of faunal remains were based on skeletal part frequencies, damage to bones, and ethnographic accounts of butchering techniques such as those documented by Wilson (1924) and Wissler (1910) (White 1952, 1953, 1954, 1955). Evidence for butchery in the form of cut marks was already recognized by nineteenth century researchers in Europe (Lartet 1860; Lartet & Christy 1865-75). It was a century later, however, that researchers started systematic studies of cut marks on animal bones (Guilday et al. 1962; but see Martin 1910). Several researchers followed White’s methodological lead in interpreting faunal remains (e.g., Frison 1971a, 1971b, 1974; Guilday et al. 1962; Kehoe & Kehoe 1960; Wheat 1972). Similarly, early interpretations of animal bones found in association with Early Stone Age artefacts in Africa did not take into account
the complicating effects of taphonomic processes (e.g., Clark 1972; Dart 1957; Isaac 1971, 1977, 1978b; Leakey 1960; Leakey 1971).

It was only from the late 1970’s that numerous faunal analysts aimed specifically at identifying taphonomic agents before making inferences about human and hominid behaviour (see references cited in section 6.4.1). A pioneer in taphonomic studies, and considered by many as the ‘father of cave taphonomy’ is C. K. Brain (e.g., 1967a, 1967b, 1969, 1981, 1989). Through taphonomic studies like those conducted by Brain, researchers established among other things, that due to differential density, all bones do not have the same potential for surviving taphonomic processes and that many non-human processes produce marks on bones that mimic marks produced by human butchers. In this way, results from taphonomic research compelled scholars to seriously question early interpretations of faunal assemblages, particularly those based on frequencies of skeletal parts.

The number of studies cited in section 6.4.1 illustrates the importance placed on the reconstruction of hominid dietary behaviour, specifically carcass acquisition, butchery and meat eating. Particular emphasis was placed on carcass acquisition strategies practiced by hominids, because techniques for identifying such behaviour are crucial to address socioecological issues regarding human behavioural evolution (e.g., Binford 1985; Blumenschine 1986a; Brain 1981; 1995; Bunn & Ezzo 1993; Isaac & Crader 1981; Lupo 1994; Marean 1989; Milo 1998; Oliver 1994 and references therein; Selvaggio 1998; Washburn & Lancaster 1968).

Although cut marks on animal bones were recognized as evidence for butchery by the nineteenth century, only recently most zooarchaeologists agree that butchery marks, among other types of bone surface modification, are the most convincing indicators of human and hominid involvement with animal bones (e.g., Behrensmeyer 1986; Binford 1981; Blumenschine 1988a; Blumenschine et al. 1996; Bunn 1983b; Bunn & Ezzo 1993; Bunn & Kroll 1986; Fisher 1995; Lyman 1987a, 1994b; Milo 1994, 1998; Potts 1984b; Shipman 1986a; Shipman & Rose 1983b). Milo (1994 and references therein) discussed the complexities and limitations associated with alternative methodologies, such as skeletal part frequencies and mortality profiles, for evaluating human or hominid dietary behaviour (also see Bartram & Marean 1999; Klein et al. 1999; and references in these papers). Bartram and Marean (1999) point out that, not only are skeletal part frequencies altered when shaft fragments –previously ignored by many faunal analysts - are included in analyses, but that their exclusion will result in under representation of filleting cut marks on limb shaft
fragments (also see Milo 1994). As discussed later in chapters 4 through 6, filleting cut marks, as opposed to but as well as disarticulation cut marks, are indicators of the type of access hominids gained to resources of animal carcasses. The under representation of filleting cut marks due to analytical biases, therefore, may have a significant impact on the final interpretation of cut mark patterning in faunal assemblages.

Because bone surface modifications such as cut marks and carnivore tooth marks provide direct evidence for human and carnivore involvement with bones, these features are commonly used to reconstruct hominid dietary behaviour at Upper Pleistocene and Plio-Pleistocene sites (e.g., Binford 1981, 1983, 1984c, 1988; Blumenschine 1988a; Blumenschine & Marean 1993; Bunn 1981, 1983b; Bunn & Kroll 1986; Lupo 1994; Marshall 1986; Milo 1994, 1998; Oliver 1994; Potts 1983, 1984a; Potts & Shipman 1981; Selvaggio 1994; Selvaggio 1998; Shipman 1986a, 1986b). The studies cited above were directed towards establishing the timing of hominid access to animal carcasses. Among researchers there is widespread debate about the manner in which hominids acquired resources from large game during the Plio-Pleistocene (e.g., Binford 1981, 1984c, 1988; Blumenschine 1986a, 1987; Bunn 1981; Bunn & Ezzo 1993; Bunn & Kroll 1986, 1988b; Chase 1988; Graves 1991; Isaac 1978b; Klein 1989a, 1992, 1999; Marean 1989; Potts & Shipman 1981; Selvaggio 1998; Shipman 1983, 1986a; Speth 1989; Stiner 1991; Turner 1992). It is important to bear in mind, however, that even modern hunter-gatherers practice a combination of hunting and scavenging in acquiring animal tissues (e.g., Bartram 1993a; Bunn et al. 1988; O'Connell et al. 1988b; Yellen 1977b). Recently, Milo (1994, 1998) argued that by the Upper Pleistocene, hominids were hunting and scavenging for tissues of large animals.

The literature on butchery, particularly that related to early hominid behaviour and the emergence of behavioural modernity, is burdened with attempts at providing evidence for either hunting or scavenging on the part of hominids. However, as noted above, modern hunter-gatherers practice a combination of hunting and scavenging in acquiring resources from animal carcasses. This is particularly true of larger animals because they are not consumed as rapidly or as completely as carcasses of smaller animals by primary non-hominid predators and carnivores (e.g., Blumenschine 1986a; Sutcliffe 1970; see references in LeMoine & MacEachern 1983). The carcasses of large animals, therefore, offer a better opportunity for scavenging than carcasses of small animals (e.g., Blumenschine 1986a, 1987), even to technologically sophisticated hunter-gatherers.
The reader will note, for example in chapter 6, that I place less emphasis on hunting versus scavenging because modern hunter-gatherers hunt and scavenge and because unambiguous evidence for hunting as opposed to killing, is almost entirely absent from the archaeological record (see Milo 1998 and references therein). I suggest, therefore, that it is the placement or status of hominids within the sequence of meat eaters that is more readily evaluated than hunting or scavenging as such. I believe, particularly in the case of early hominid behaviour, that it is important to establish hominids’ ability to acquire animal resources in relation to the abilities of other non-hominid carnivores. One of the features that distinguishes us from non-human animals is that people have the ability to control the natural environment. I believe, therefore, that in researching hominid evolution, it is important to establish whether early hominids were capable of manipulating and/or controlling other carnivores in establishing a dietary niche for themselves. More specifically, concerning early hominid behaviour and the emergence of behavioural modernity, I believe it is critical to establish the status of hominids in the sequence of meat-eaters. In this scenario it is less important to establish which animal(s) tracked and immobilized prey and more important to establish which animal(s) controlled the accessibility of animal resources. In later chapters, specifically chapter 6, I demonstrate that comparisons of cut mark patterns between the actualistic assemblage produced during the MRM study and a Plio-Pleistocene and Upper Pleistocene site enable us to place hominids within a sequence of meat-eaters and that hominids’ status in the chain of meat eaters changes through time. Once hominids have been placed in the sequence of meat eaters, we can begin to develop models concerning strategies employed to acquire and control access to animal carcasses.

Although undisputed cut marks are indicative of hominid involvement with animal carcasses, the nature of such involvement can not be established from the mere presence or absence of cut marks or other butchery damage. It was already suggested in the 1950’s and 1960’s that butchery damage and cut marks at specific anatomical locations were associated with particular butchery activities and that the numbers of cut marks were indicative of butchery intensity (Guilday et al. 1962; White 1952, 1953, 1954). However, associations between cut marks and butchery activities were not based on detailed and well-controlled actualistic research. Associations were made more or less on grounds of common sense and expectations relative to the general anatomy of animals. Diagnostic criteria and interpretative guidelines set out by Guilday et al. (1962) guided the recognition and interpretation of cut marks for nearly 20 years. Although several ethnographic accounts of butchery by indigenous
peoples in North America provided some detail of specific butchery activities (see references in e.g., Wheat 1972; White 1952, 1953, 1954, 1955), these accounts were not made from the perspective of the manner in which butchery behaviours are manifested archaeologically.

In attempting to answer butchery related questions, archaeologists require an understanding of the manner in which specific butchery activities affect the final nature and composition of zooarchaeological assemblages. Further, along with the recognition of taphonomic effects on bone surfaces in the late 1970’s, considerable research was conducted toward distinguishing real from pseudo cut marks. I discuss the latter issue in more detail in section 2.3. Additional ethnographic work by Binford (1978; Binford & Bertram 1977), including the study of butchery practices and the resultant damage to bones, provided information for constructing a framework for interpreting cut marks on archaeological bones (Binford 1981). Binford developed models, which he termed middle-range theory, for interpreting butchery-marked bones from archaeological deposits. Based on principles of uniformitarianism, studies of this nature include ethnoarchaeology and experimental archaeology and are collectively referred to here as actualistic studies. Currently, the vast majority of interpretations of butchery-damaged bones are based on actualistic studies (see references cited in chapters 5 and 6). In fact, most interpretations of cut-marked bones have been based to a lesser or greater extent on Binford’s ethnographic observations made over 20 years ago (e.g., Binford 1981, 1984c, 1988; Bunn 1982b, 1983b; Bunn & Blumenschine 1987; Bunn & Ezzo 1993; Bunn & Kroll 1986, 1988b; Cruz-Uribe & Klein 1994; Gifford 1981; Gifford-Gonzalez 1989a; Lupo 1994; Lyman 1994b; Milo 1994, 1998; Potts 1983; Selvaggio 1994, 1998; Shipman 1983, 1986b; Thomas & Mayer 1983; Toth 1982; Villa et al. 1986).

1.4. DISSERTATION STRUCTURE AND CONTENTS OF CHAPTERS

A review of actualistic research pertaining to butchery studies in archaeology is presented in chapter 2. In this chapter I provide a very brief discussion of uniformitarianism and actualism. Then I provide a summary discussion of research into the nature of cut marks, butchery experiments performed by researchers, and ethnographic observations of habitual butchers. Chapter 2 is completed by a discussion of the status of actualistic butchery studies and situates the MRM study in this area of research.
In chapter 3 I describe the methodologies and samples employed in the MRM study. Included is a description of the butcher and the animals that were processed as well as methods of recording butchery activities and cleaning the bones for curation. I also describe the types of butchery damage that were recorded as well as the methods used for examining bone surfaces and recording butchery marks. Techniques of quantification, analysis, and illustration are described in the last two sections of chapter 3.

In chapter 4 I present the results of observations made during the actualistic butchery study at MRM. Due to the large number of figures associated with the presentation of results in chapter 4, I present the bulk of the figures for this chapter in a second volume. This allows the reader to view the appropriate figures in the second volume while reading the associated descriptions of butchery and the resultant cut marks in the first volume. First I present a general description of different butchery procedures including evisceration, skinning, disarticulation, and filleting. This is followed by a detailed, bone by bone description of different butchery procedures and their resultant cut marks. This section is the core of the dissertation and is presented in such detail because a similar account is not currently available in the literature. In this section, the specialist will find detailed information on butchery and its material manifestation that is not currently available in the literature. The non-specialist will find this section very long and detailed and I advise that such readers concentrate on the first part of chapter 4 and the general observations section (section 4.5) comprising the last part of this chapter. The general observations section includes brief discussions of; 1) the relationship between butchered bones and the frequency of butchery-marked bones, 2) the anatomical placement of cut marks with unambiguous behavioural correlates, which includes an inventory and graphic depictions of cut marks and their associated butchery procedures, 3) the frequencies and locations of cut marks on small and large bovids, 4) butchery with metal and stone tools, 5) disarticulation and filleting cut marks as indicators of carcass acquisition strategies, and 6) evisceration cut marks as indicators of carcass acquisition strategies. In each of these discussions in the general observations section, the reader is pointed to the appropriate section when certain issues are discussed in more detail elsewhere in the dissertation.

In chapter 5 I compare the results of actualistic butchery studies at MRM with Binford’s (1978, 1981) observations of butchery practices by the Nunamiut. I start with a brief discussion of the interpretative value of cut mark placement and orientation for interpreting carcass acquisition strategies from archaeological faunal assemblages. Next I summarize both
Binford’s and my methodology for recording butchery activities and resultant cut marks. This is followed by a comparison between Binford’s cut mark codes and their associated functions and those documented during the MRM study. Chapter 5 is concluded with a discussion concerning the merit of both Binford’s and my interpretative frameworks for interpreting butchery marked bones from archaeological sites.

Chapter 6 contains discussions regarding the implications of the MRM study for reconstructing butchery and carcass acquisition strategies practiced by hominids in the Upper Pleistocene and Plio-Pleistocene. First, an issue earmarked for further discussion in chapter 4 is considered regarding the relationship between the number of butchered bones and the frequency of cut-marked bones. Reconstructions of hominid dietary behaviour based on cut-marked bones from the sites of Klasies River Mouth and FLK Zinjanthropus are reviewed and certain methodological issues are discussed. Observations from the MRM study are applied to butchery data from these sites. Previous reconstructions (e.g., Bunn & Kroll 1986; Milo 1994, 1998) of carcass acquisition strategies are presented for both sites and alternative explanations are offered in light of the MRM observations. The final part of this chapter comprises a comparison of the cut mark data from Klasies River Mouth and FLK Zinjanthropus and some interpretations are offered as to how these assemblages differ in terms of hominid behavioural evolution in the Upper Pleistocene and Plio-Pleistocene.

Chapter 7 summarizes the most significant results of this study and highlights certain gaps in butchery studies in archaeology that require filling through additional problem-oriented actualistic butchery studies and continued study of butchery-damaged bones from archaeological sites.
CHAPTER 2

A REVIEW OF ACTUALISTIC RESEARCH RELATED TO BUTCHERY STUDIES IN ARCHAEOLOGY

2.1. INTRODUCTION

This chapter concerns the nature and development of actualistic butchery studies in archaeology. These studies have been pivotal for interpreting animal remains from archaeological sites for nearly fifty years, and like other sciences, actualistic butchery studies are based on uniformitarian principles. In chapter 1 I provided an overview of butchery studies, and showed that, with the recognition of the confounding effects of taphonomic processes on archaeological faunal assemblages, many researchers have turned to studying modern processes that affect the final nature and composition of bones in archaeological sites.

I start, in section 2.2, with a very brief summary concerning uniformitarianism in actualistic butchery studies. In section 2.3 I discuss the nature and diagnostic features of cut marks as developed through actualistic studies. Section 2.4 presents an overview of actualistic butchery observations. The first part, section 2.4.1, concerns observations made by researchers performing butchery activities, and the second part, section 2.4.2, relates observations made of habitual butchers in ethnographic contexts. Observations made during such actualistic studies were subsequently used, for example, to reconstruct dietary and social behaviour of hominids in the Late Pleistocene and Plio-Pleistocene. I present selected examples of the application of actualistic results to archaeological assemblages in more detail in chapters 5 and 6. Finally, in section 2.5 I outline the status of actualistic butchery studies and situate the MRM research in this endeavor. Matters regarding the quantification and analysis of cut marks are dealt with in a piecemeal fashion in chapters 3 through 6 (also see e.g., Bartram 1993a; Lyman 1987a, 1994b; Milo 1994, 1998).
To gain a better understanding of butchery processes and their material consequences, many researchers have turned to actualistic research with the aim of developing models for identifying and interpreting archaeological phenomena. Actualistic research is not new to butchery studies in archaeology (e.g., Lartet 1860; Nilsson 1868), but was only rekindled with rigor after the recognition of taphonomic biasing agents in the late 1970’s and early 1980’s (e.g., Binford 1978, 1981; Binford & Bertram 1977; Brain 1967a, 1967b, 1969, 1981; Hill 1979a, 1979b). The nature of actualistic studies, based on uniformitarian principles, and their value to the study of archaeological remains has been discussed at considerable length by various authors (e.g., Bartram 1993a; Binford 1978, 1981, 1983; Gibbon 1984; Gifford 1981; Gifford-Gonzalez 1989b, 1991, 1993; Gorecki 1985; Gould 1977, 1978, 1980; Lyman 1994b; Potts 1987; Saitta 1992; Trigger 1989; Yellen 1977a, 1977b).

The main point to be drawn from discussions about uniformitarianism and actualism is that “… the analytic process involves the association of modern results with particular modern processes. When similar results, some formed in ancient times and others formed in modern times, are found, the inference is made that the processes were the same or at least similar in both the past and present cases” (Lyman 1994b: 47). Although two main criticisms have been made against actualistic approaches (Lyman 1994b: 50-51), Gould maintained that “there is no such thing as the final or ultimate interpretation – only better and better approximations of past reality” (Gould 1980: 46).

Although certain cautionary tales regarding the use of actualism are warranted in some instances, no alternatives have been proposed (Lyman 1994b; Trigger 1989). It is from this perspective that actualistic butchery studies were conducted at MRM, and in accordance with Gould’s viewpoint, the MRM observations are not intended to provide the ultimate model for interpreting cut marks, but rather as another step towards understanding the material consequences of butchery activities. Below I discuss actualistic butchery studies in three parts; the first, section 2.3, deals with the study of cut marks and their diagnostic features, the second part, section 2.4, is a discussion of observations made of butchery activities in modern contexts. Section 2.4 is divided into observations made by researchers performing butchery activities (section 2.4.1), and observations made of habitual butchers in ethnographic contexts (section 2.4.2).
2.3. CUT MARKS AND THEIR DIAGNOSTIC FEATURES

Diagnostic criteria for identifying cut marks, as presented by Guilday et al. (1962), were used to identify cut marks on bones from archaeological sites for almost 20 years. In the early 1980’s, a few researchers argued that certain microscopic features of cut marks were only visible via scanning electron microscope (SEM), and that such features were essential and adequate for the recognition of cut marks (Potts & Shipman 1981; Shipman & Rose 1983a, 1984). The form of cut marks have been described by several authors (e.g., Bunn 1981, 1983b; Cook 1986; Greenfield 1999; Lyman 1987a; Shipman 1983; Walker & Long 1977; see section 3.6 for additional references). Bunn (1991), however, pointed out that microscopic features proposed as characteristic of cut marks by Shipman and her colleagues are not always present, and are visible through a light microscope at low magnification. Similarly, Milo (1994: 24) pointed out that less than 3% of stone tool cut marks produced during experimental butchery displayed morphological features supposedly necessary for the identification of cut marks. Several specialists have debated the most appropriate technology for identifying cut marks (e.g., Blumenschine & Marean 1993; Blumenschine et al. 1996; Bromage & Boyde 1984; Milo 1994, 1998; Oliver 1994; Shipman 1986a; White 1992). Currently, most zooarchaeologists agree that stereomicroscopic examination of bone surfaces is necessary, and that lists of diagnostic criteria, like those presented by Lyman (1987a) and Milo (1994), only serve as guidelines, and that contextual and configurational information must be considered in accurately diagnosing cut marks.

According to the uniformitarian principle, the study of marks on bones caused by known agents, through experiments and well controlled actualistic research, improves zooarchaeologists’ ability to identify agents responsible for marks on bones from archaeological assemblages. Here I deal specifically with research into the nature of cut marks and the distinction between real cut marks and cut mark mimics. To the best of my knowledge, the earliest example of an actualistic approach in validating the diagnostic features of cut marks on bones from an archaeological site is that of Lartet (1860). “The fragments of Aurochs exhibiting very deep incisions, apparently made by an instrument having a waved edge … I have obtained analogous results by employing as a saw those flint knives found in the sands of Abbeville” (Lartet 1860 [1969: 122]).

It was more than a century later that researchers again started investigating and describing the morphological attributes of cut marks (Guilday et al. 1962; but see Martin 1910). Lyman (1987a) provides a review of the use of mark morphology for identifying cut marks.
marks. Here I focus on actualistic approaches to develop models for identifying cut marks. Walker and Long (1977) performed a series of butchery experiments with different types of stone tools to determine the types of cut marks produced by different cutting edges. They suggested that the type of tool used for butchery might be identified from the morphology of cut marks. Walker and Long (1977) also found that the form of a cut mark is determined by the pressure and angle of application, length of the cutting edge, and the type of cutting action employed during butchery.

Potts and Shipman studied numerous marks, produced by known events, with a SEM “to clarify the interaction between these forces and the microscopic structure of the bone” (1981: 577). Bunn (1982b: 43) “conducted a series of experiments using stone tools to butcher domestic and wild ungulate carcasses …”. Bunn (1982b) subsequently studied the nature of the marks produced during his experimental butchery. Similarly, Shipman and Rose (1983b) performed a series of experiments, and among other things, produced cut marks on bones with stone tools made of different raw materials. They found that marks made with different raw materials were not significantly different. Through experimentation, Toth and Woods (1989) have shown that butchery can be conducted with mollusk shells, and that shells produce cut marks on bone that are similar to those produced by stone tools.

Milo (1994) butchered two small African antelope with stone tools and provides a list of morphological attributes associated with stone tool butchery marks. Both Milo (1994) and Haynes (1991) point out that cut marks produced in experimental settings by some researchers, were not made during actual butchery and that marks were rather made directly to bone surfaces after the flesh had been removed (e.g., Shipman 1983; Walker & Long 1977). Recently, in a study concerning the origins of metallurgy, Greenfield (1999) conducted a series of experiments in producing cut marks with stone and metal tools. He found that marks produced by the two raw materials were significantly different when examined with a SEM. Overall, the sides of metal cut marks were smooth, while those produced by stone tools were irregular (Greenfield 1999).

Numerous observations and experiments pertaining to the effects of trampling on bones have been carried out (e.g., Behrensmeyer et al. 1986 and references therein; Fiorillo, 1989; Olsen 1988; Shea 1993). Behrensmeyer et al. (1986, 1989) and other researchers have suggested that attributes other than morphological features of marks on bones must be considered to distinguish trample marks from cut marks, because trampling can produce cut mark mimics. However, through macroscopic and microscopic comparisons of marks on
bones produced during experimental trampling and butchery, Olsen and Shipman (1988) suggested that there were considerable differences between the marks produced by the two procedures. An additional trampling experiment by Fiorillo (1989) demonstrated that trample marks are very similar, even under SEM inspection, to butchery marks. Through studying bone surfaces from a deposit predating the presence of humans, Oliver (1989) detected marks similar to cut marks.

In addition to the few examples presented above, several experimental studies as well as the examination of bones in assemblages pre-dating the presence of humans showed that butchery mark mimics may be produced by a variety of taphonomic processes (e.g., Behrensmeyer et al. 1986 and references therein; Blumenschine & Selvaggio 1988, 1991; Bunn 1981; Capaldo & Blumenschine 1994; Cook 1986; Fiorillo 1989; Lyman 1987a; Olsen & Shipman 1988; Potts & Shipman 1981; Shea & Klenck 1993; Shipman & Rose 1983b, 1984). From the literature it is clear that cut mark form and internal morphology is variable and that the morphological features of a mark are not always adequate for its identification. This is particularly true for studies of bones from sites with complex taphonomic histories and where cut marks are few and far between. In a series of blind tests, however, Blumenschine et al. (1996) showed a high degree of correspondence and accuracy in the identification of known marks by both specialist and novice zooarchaeologists. A similar series of blind tests is required where cut mark mimics are included in the experimental sample. We currently lack data on the frequency with which cut mark mimics are misidentified as cut marks and how frequently non-human agents produce pseudo cuts. In contexts where non-human taphonomic processes were likely involved in the taphonomic history of a site, analysts should consider contextual and configurational criteria along with morphological features when attempting to identify the agents responsible for marks on bone surfaces.

2.4. ACTUALISTIC BUTCHERY OBSERVATIONS

I now turn to discussions of observations made of butchery activities in modern contexts. Lyman (1987a, 1994) has suggested that the variables affecting butchery are too numerous and complex for the reliable use of analogues. In subsequent chapters I demonstrate that this is not necessarily so. The underlying uniformitarian principle is that animal anatomy was roughly the same in the past as it is today, and that, due to the structure of animals,
accomplishing certain butchery tasks requires more or less the same butchery activities. Consequently, butchery activities and their resultant butchery damages observed in a modern context may be used to interpret butchery-damaged bones from archaeological sites.

Actualistic butchery studies can be divided into at least two broad categories. The first, section 2.4.1, comprises experimental butchery performed by researchers using different types of tools to determine the effectiveness of different tools, the activities required for different butchery processes, the types and placement of cut marks produced by different activities, as well as the use-wear or damage to stone tool cutting edges. The second category, section 2.4.2, entails observations of habitual butchers, usually extant hunter-gatherers, to investigate techniques employed for different butchery operations and sometimes the study of marks resulting from observed butchery activities. Below I discuss these two categories in turn, starting with experimental butchery conducted by researchers.

**2.4.1. Observations made by researchers conducting butchery experiments**

The following is a chronological account of different types of experimental butchery studies conducted over the last 50 years or so. The reader may wish to see the original publications for details on methodology and for additional references. I discuss methodologies employed if they are pertinent to this dissertation. I do not discuss experiments involving the effects of marrow extraction and subsequent damage to bone surfaces, as percussion marks and fragmentation of bone are not included in the current study. Notwithstanding early discussions about experimentation with stone artefacts (Nilsson 1868), one of the earliest examples of butchery experiments is that reported by Leakey (1953). Through experimental butchery, Leakey discovered that larger stone tools were generally more effective than smaller forms. Another example of early butchery experiments carried out to evaluate the efficiency of specific tools, was that conducted by Biberson and Aguirre (1965). They discovered that bone tools are effective for butchery and that bone tools were as efficient as tools made of stone.

An experimental butchery study performed with stone tools showed that the accumulation of animal fats on cutting edges may render the tools blunt before any use-wear was created on the cutting edges (Brose 1975). Consequently, stone tools from archaeological sites displaying no evidence of use-wear may have been used, but were discarded due to the blunting effect of animal fats. Such tools may therefore appear unused on the grounds of
microwear analysis, and may retain cutting edges as sharp as the day the tools were deposited. Akerman (1975) used tools made from shell in experimental contexts.

Similar to Leakey’s (1953) findings, Frison (1974), through experimental butchery, suggested that larger stone tools were more effective for butchery relative to smaller ones. Frison et al. (1976) conducted a series of butchery experiments with metal and stone tools and found the former superior. Walker (1978) performed butchery activities using stone tools with different cutting edges. He discovered that unretouched tools were generally more effective than retouched tools and that different animal species required different types of tools to accomplish particular butchery tasks.

In another suite of butchery experiments, Frison (1978) performed tasks with different stone tool forms and examined the bones for butchery damage after they were cleaned. Frison does not outline his methodology for identifying or recording butchery marks, but it appears that bone surfaces were not examined microscopically. In addition, Frison does not provide an inventory of cut marks associated with particular butchery activities. He suggests that use-wear on the cutting edges of tools can not be applied to determine the activity for which a tool was used because butchery included a wide range of tool use (Frison 1978).

Bunn’s (1983b) interpretation of bones from early hominid sites were based on comparative studies of bones from known taphonomic events, including sets of experimentally butchered bones (Bunn et al. 1980; Bunn 1981, 1982b). However, Bunn never provided an inventory of butchery marks and their behavioural correlates. Jones (1980) conducted butchery experiments with different stone tool forms and found that large, retouched tools were more effective than small, unretouched flakes. He suggested that larger tools were better because of their weight, long cutting edges, and because they were comfortable to hold and manipulate (Jones 1980: 153). Jones describes the butchery procedure he employed as taught to him by his Wakamba colleagues at Olduvai.

Through experimental butchery and examination of microwear polishes on stone tool cutting edges, Keeley and Toth (Keeley 1980; Keeley & Toth 1981) argue that the use-wear damage on stone tools corroborate the cut mark evidence on bones from some early archaeological sites. They suggest this provides strong evidence for meat eating by early hominids. Stanford et al. (1981) used both stone and bone tools for experimental butchery. They suggest that “the detailed documentation of these experiments made it possible for us to assess behavioral processes responsible for the creation of morphological patterns observed
in the archaeological record and enhanced our ability to interpret fossil specimens” (Stanford et al. 1981: 438-439). However, they did not present detailed information concerning the association of specific butchery activities with particular butchery marks.

Using different stone tool forms during experimental butchery, Toth (Keeley & Toth 1981; Toth 1982, 1985; Toth & Schick 1986) showed that unretouched flakes could be used to accomplish most butchery tasks, and that larger flakes were more efficient for butchering larger animals. By butchering a bison with stone and bone tools, Johnson (1985) found that bone tools were more effective than stone tools for accomplishing certain butchery tasks, such as severing the neck.

Apart from the dissection of a mule deer (Gifford-Gonzalez 1989a), experiments in removing a variety of animal tissues with stone tools (Olsen & Shipman 1988), and butchering with shell tools (Toth & Woods 1989), there is a dearth of experimental butchery performed by researchers during the period between 1985 and 1994. Milo (1994) butchered two small African antelope to investigate the different actions required to accomplish certain tasks and to examine the effectiveness of different stone tool forms. He suggested that the order in which filleting and disarticulation occurs would affect the frequencies of marks at certain anatomical locations. Milo also found that stone tools could be used effectively in ways quite different from strategies employed with metal tools. Although Milo “took detailed written notes during the entire procedure so that the operation responsible for each mark could be identified” (1994: 112), he does not present detailed information linking certain cut marks with specific butchery activities.

During a series of experiments including stone tool butchery of carcasses first fed upon by carnivores, and carcasses fed upon again after stone tool butchery, Selvaggio (1994, 1998) demonstrated that epiphyseal ends, and therefore marks at epiphyses, are heavily impacted by carnivores after butchery. Carnivore ravaging after butchery, however, did not significantly alter the incidence of tooth marks and butchery marks on midshaft fragments. The most recent experiment including the use of stone tools is Schick et al.’s (1999) study of stone tool manufacture and use by a captive bonobo (Pan paniscus). The researchers found that the bonobo consistently selected larger pieces of stone flaking debitage for cutting activities (Schick et al. 1999: 829-830).

The most significant results stemming from the above-mentioned studies are summarized as follows: 1) different forms of stone tools can be used for butchery, including unretouched
flakes, but larger pieces are generally preferred; 2) implements made of bone and shell are effective butchery tools; 3) metal tools are more effective than stone tools and stone tools can be used effectively with butchery actions different from those employed when using metal tools; 4) microwear on cutting edges of stone tools may be indicative of the tissues cut with an implement, but tools may be discarded before use-wear develops because of blunting through the buildup of animal fats, and the variety of tissues cut during butchery may obscure the identification of a single responsible tissue (e.g., meat); 5) cut marks at epiphyses may be deleted by carnivore ravaging, while midshaft fragments are not significantly effected by carnivores after butchery.

Although major advances were made through the previously mentioned experiments, these studies are lacking in three main areas. First, cut marks produced through experimental butchery have not always been located and identified microscopically. Secondly, due to lack of experience, researchers performing butchery may produce cuts at anatomical locations and in frequencies different from those produced by habitual butchers. Finally, and I believe most importantly, while some researchers recorded butchery procedures in detail and examined the bones for resultant butchery damage (e.g., Bunn 1982b; Frison 1978; Gifford-Gonzalez 1989a; Milo 1994; Stanford et al. 1981), none provide detailed inventories of specific cut marks, their frequencies, and their associated behavioural correlates. My impression is that the deficiency of such inventories is due to the predicament of distinguishing between cut marks produced, for example, during filleting and those produced by disarticulation. Even if careful notes are kept, where both filleting and disarticulation actions were involved in producing cut marks on the same skeletal element, it appears impossible to separate marks because of behavioural overprinting at certain anatomical locations. This problem is particularly acute at and around epiphyses. Palimpsests of cut marks produced by disparate butchery activities are very difficult to disentangle according to activity unless detailed butchery observations can be reviewed on, for example, video (Nilssen 1994). I believe it is through careful examination of butchery actions via footage that the researcher can detect attributes of cutting actions, such as anatomical location, orientation and angle at which cuts are made, associated with specific butchery tasks. Of course, the only way to attribute actions to cut marks with absolute certainty is to generate actualistic assemblages where disparate butchery actions are separable. I discuss and apply these ideas in subsequent chapters.
2.4.2. Ethnographic observations of habitual butchers

I now discuss butchery observations made of habitual butchers in ethnographic contexts. Like the previous discussion, I provide a chronological overview of observations made during the butchery of animal carcasses. I mostly restrict my discussion to observations made of butchery and the subsequent analysis of butchery-marked bones. Several ethnoarchaeological studies have focused on the skeletal part frequencies associated with specific types of ethnoarchaeological sites, for example kill/butchery sites and base camps, but I avoid discussing these studies here since this dissertation is specifically concerned with modification of bone surfaces as caused by butchery activities. I do not include every ethnographic account of butchery, but rather provide an overall picture of the type of information collected and published by various researchers.

White (1952, 1953, 1954, 1955) and Wheat (1972) cite some of the earliest ethnographic accounts of butchery. However, such accounts were not made from an archaeologist’s perspective and therefore the archaeological manifestations of the observed butchery activities were not recorded. Nevertheless, archaeologists such as White and Wheat proceeded to use such accounts to interpret bones recovered from archaeological sites (also see Frison 1971a, 1974; Kehoe & Kehoe 1960). Gould (1967) provides an account of butchery strategies employed by aboriginal Australians in processing kangaroo. Although Gould tells us about the portions into which the animal was butchered, he does not provide any detail on the manner in which the butchery activities affected the bones (Gould 1967). Although Akerman (1975) informs us that Australian aborigines made use of shell tools for butchery, she did not actually observe butchery conducted with such tools.

Yellen (1977b) provides a detailed account of the typical procedures involved in butchery by the !Kung bushmen. Yellen describes 28 steps in the butchery procedure, but fails to provide detailed descriptions of the anatomical locations at which specific butchery operations took place. Yellen did not conduct a detailed study of the bone surfaces to determine the effects of the butchery process and does not provide an inventory of butchery activities and their physical impact on bone surfaces. However, Yellen made the very important observation that it is the final preparation of animal products for cooking and consumption, consumption-related activities, as well as post-depositional taphonomic processes that affect the final nature and composition of faunal remains in archaeological assemblages. Yellen (1977b) points out that besides the work of Brain (1969) and Olsen (1967), these issues have been ignored.
In their observations of sheep butchering by the Navajo, Binford and Bertram (1977) noted a very regular procedure for butchery. Although Binford and Bertram describe the butchery procedures in some detail, they fail to present the impact of butchery activities on the bones. They do not provide an inventory of butchery activities and their resultant damage to bone surfaces.

During his study among the Nunamiut, Binford (1978) made detailed observations of butchery activities and then studied the bones for resultant butchery damage. The results from this study provided the information for an inventory of butchery activities and their associated cut marks (Binford 1981). Binford pointed out that butchery consisted of a series of acts starting at the kill site and ending with consumption and the final disposal of bones (1978). Referring to other ethnographic accounts (Belcourt 1944; Gilmore 1924; Kehoe 1967; Wissler 1910), Binford notes that butchery procedures are seldom the same and that the context within which butchery is conducted is important in determining procedures employed. Factors that affect butchery include the number of animals involved, transport, the amount of food available in storage, and so forth (Binford 1978). Although these factors do determine the nature of butchery, I show in subsequent chapters that these factors do not play as critical a role in the anatomical placement and frequencies of cut marks as researchers have believed till now. More important, in my opinion, is the fact that in processing a carcass, people are interested in extracting consumable (in the broad sense) tissues, and it is during the removal of tissues that cut marks are created at certain places on the carcass and with certain intensities. I consider these matters in more detail in subsequent chapters, particularly chapter 6.

Because the butchery section of Binford’s (1981) book is one of the focal points of this dissertation, and indeed the catalyst for the research presented here, I discuss his methodologies and findings in greater detail in Chapter 5. Here, however, I note that Binford’s (1978) study is the first to make a concerted effort to link cut marks on bones with the butchery activities that produced them. Nevertheless, methodological concerns place some restrictions on the interpretative integrity of Binford’s (1981) inventory of butchery marks and their behavioural correlates.

Brain (1981) provides a detailed account of goat butchery by Hottentots, but does not link specific butchery marks with associated butchery activities in any detail. Brain noted that the introduction of cooking pots would alter the manner in which certain skeletal portions are butchered. Although Bunn (1982b) recorded the Khwee San butchery of an eland in great
detail and studied butchery damage on bones from several ethnoarchaeological sites, he too does not provide any information regarding cut mark placement and frequencies produced by specific butchery activities. Similarly, Crader (1983) observed butchery episodes conducted by the Valley Bisa and studied bones for butchery damage. However, she does not provide an inventory of butchery damage and their related activities.

Another example of detailed accounts of animal butchery is Bunn et al.’s (1988) ethnoarchaeological study of the Hadza. Although the authors suggest that a more detailed account of the butchery damage produced by the Hadza would be published in the future (Bunn et al. 1988), no inventory linking specific butchery activities to certain cut marks has been published to date. Also based on ethnographic observations of the Hadza, O’Connell et al. (1988b, 1992) describe the processing of large animals from the acquisition of carcasses through the disposal of bones after consumption. They suggest that some of the differences between butchery practices of the Hadza and Nunamiut are partly attributable to climatic variability and different strategies of storage and/or consumption (O’Connell et al. 1988b). Like other researchers referred to above, O’Connell et al. (1988b, 1992) fail to provide a list of butchery activities and their associated damage to bone surfaces even though they hint that the bones will reflect damage produced by particular butchery activities (see Lupo 1990). Lupo (1990) does not present inventories of butchery activities and their associated bone damage signatures.

Gifford-Gonzalez (1989a) describes the sequence in which the Dassanetch of Kenya butchered four goats. The Dassanetch used metal knives, hammerstones, and stone anvils for butchery. Gifford-Gonzalez points out that she only examined selective cut marks microscopically, and it is not clear whether she examined all bone surfaces for cut marks with the aid of a microscope (1989a: 188-189). She attributed functions to cut marks at specific anatomical locations on the basis of her ethnographic observations, on the dissection of a mule deer, and on research by Binford (1981), Frison (1974), Guilday et al. (1962), Hole et al. (1969), and von den Driesch and Boessneck (1975) (Gifford-Gonzalez 1989a: 188). As previously pointed out by other researchers (e.g., Brain 1981; Yellen 1977b), Gifford-Gonzalez argues that there is a lack of research into the effects of cooking technology on the procedures employed for carcass processing. She argues that cooking technology will therefore have an effect on the nature of butchery marks. Gifford-Gonzalez notes that much of the research into butchery studies and resulting bone damage was conducted in situations involving mass kills (e.g., Binford 1978; Frison 1970), and that these scenarios are not
appropriate for interpreting bones from sites where single or a few animals were processed at a time (Bunn et al. 1988; Gifford-Gonzalez 1989a: 200, 1993; O'Connell et al. 1988b, 1990; Yellen 1977b).

Gifford-Gonzalez (1989a) provides detail concerning the frequencies with which cut marks occur on different skeletal portions of smaller and larger ungulates. However, since it is not clear whether all bones were examined microscopically or not, these frequencies may be more of an approximation than an accurate count of all cut marks. Nevertheless, small animals retain fewer cut marks on axial elements, including the scapula and pelvis, and Gifford-Gonzalez suggests that this is due to weaker articulations in smaller animals. However, there is not a significant difference in the numbers of cut marks on appendicular elements between the different animal size groups (Gifford-Gonzalez 1989a: 202). Although she describes, in considerable detail, the anatomical location of cut marks and their associated functions, including the actual muscles that were severed, Gifford-Gonzalez does not provide an inventory of cut marks and their associated behavioural functions. I believe this is largely due to the fact that the cut marks she observed on the Dassanetch butchered bones were the result of multiple activities, (skinning, filleting, disarticulation, etc.) and that due to overprinting of activities, all cut marks could not be attributed to a single butchery activity with any certainty. Although she presents no data to this effect, Gifford-Gonzalez suggests that bones are likely to retain fewer cut marks if meat is cooked prior to filleting, because “… it is easier to remove meat from bones once it is cooked …” (1989a: 207).

While Bartram (1993a, 1993b) provides detailed descriptions of butchery by the Kua San of Botswana, as well as the technology used for recording butchery activities, he does not provide an inventory of butchery marks and their associated behaviours. He describes the different tools used for recording butchery and states “I suspect that with further miniaturization of components, increasing image clarity, and decreasing costs, the video recorder will serve to replace virtually all others as the tool of choice for this job” (Bartram 1993a: 58). Bartram further points out that the butchery data “are not used here in any real analytical sense … [but] … will be employed as the basis for future papers …” (Bartram 1993a: 59). To the best of my knowledge the butchery data have not yet been published in a format where specific butchery marks are linked to certain butchery activities.

Marshall (1993, 1994) observed the entire butchery and sharing of meat from 5 carcasses processed by the Okiek. Although Marshall provides information regarding the butchery procedures involved in reducing a carcass into manageable portions for transport and sharing,
she does not make associations between specific butchery operations and resultant butchery marks (Marshall 1993, 1994). In an analysis of butchery marks from Hadza carcass processing (O’Connell et al. 1988a, 1988b, 1990, 1991, 1992), Lupo (1994) has shown that certain cut marks attributed to the processing of stiff and desiccated carcasses by Binford (1984c), were produced by the Hadza when processing carcasses stiff from rigor mortis. I discuss Lupo’s (1994) work in more detail in Chapter 5, but note here that an inventory of cut marks and their behavioural correlates from Hadza butchery have not yet been published. Below I suggest why the publication of such information might not be possible from the Hadza and other ethnographic butchery studies.

Results from the studies referred to above are summarised as follows: 1) early ethnographic accounts do not provide information regarding the archaeological manifestation of butchery activities; 2) some researchers report on the portions into which animals are butchered for transport and sharing, 3) some accounts offer fairly detailed descriptions of butchery sequences and associated butchery activities, sometimes explaining anatomical locations where butchery activities were performed to accomplish certain tasks, 4) several researchers point out that butchery context and the final cooking and consumption of animal tissues will affect butchery procedures, 5) some researchers reported on butchery activities and examined the bones for butchery damage, 6) O’Connell et al. (1988b) argue that differences in climatic conditions, number of animals processed, and the products desired from butchery account for the differences in butchery procedures between the Nunamiut and Hadza, 8) Gifford-Gonzalez (1989a) provides detailed descriptions of cut mark placement and their associated behavioural functions, as well as frequencies of cut marks on different anatomical parts of animals in different size groups; although she also suggests that cut mark frequencies will be altered by cooking technology, no data to this effect was presented, 9) some researchers describe the tools used for recording butchery activities and Bartram (1993a) concludes that video cameras are likely the best tool for the job; 10) a few authors suggest that their butchery mark data from observed butcheries will be published in the future, but to date there are no detailed inventories of cut marks linked to specific butchery activities as well as graphic depictions of cut mark placement and orientation, except for that presented by Binford (1981).

Although a great deal was learned through ethnoarchaeological studies of butchery, none of the researchers referred to above, except for Binford (1978, 1981) and to a lesser extent Gifford-Gonzalez (1989a), were successful in linking cut marks to specific butchery
activities. I believe this lack of resolution is mostly due to the fact that all researchers, including Binford and Gifford-Gonzalez, were faced with palimpsests of cut marks produced by disparate butchery activities. Because different butchery activities were not separable during ethnoarchaeological studies, attributing all cut marks to specific butchery activities was not possible. This situation is unfortunate given the great importance placed on studies of bone surface modification in determining taphonomic processes and agents from archaeological faunal assemblages (see references cited in section 2.1). More specifically, and as is discussed in greater depth in chapter 6, butchery activities as interpreted from the placement of cut marks is a critical criteria in determining human and hominid access to animal carcasses. Because butchery activities cannot easily be separated and controlled in ethnographic contexts, I believe actualistic butchery studies where specific activities can be separated and controlled, as was done at MRM, are critical for attributing carcass processing behaviours to particular cut marks, their frequencies and proportional distributions across different anatomical loci.

2.5. THE STATUS OF ACTUALISTIC BUTCHERY STUDIES AND PLACEMENT OF THE MRM STUDY IN THIS ENDEAVOR

The above discussion and that in section 1.3 demonstrate that inferences of past human and hominid dietary behaviour are currently based to a large extent on interpretative models constructed from observations made of modern processes and their resultant material manifestations (e.g., Bunn & Ezzo 1993; Lupo 1994; Milo 1998; Selvaggio 1998). Although several actualistic butchery studies have been conducted, there is a fundamental shortcoming in all this work. Because disparate butchery activities, such as filleting and disarticulation were not separated during ethnoarchaeological observations or experimental butcheries, researchers have not been able to distinguish unambiguously between cut marks produced by these two activities. This is particularly problematic for cut marks near and at epiphyses or areas of articulation, because it is at these localities where the distinct acts of filleting and disarticulation overlap. Further, butchery activities were normally recorded with static media, and therefore researchers could not review butchery procedures in detail to ascertain the precise locations and impacts of particular butchery activities.

Because cut marks associated with either filleting or disarticulation inform on the type of access people gained to animal carcasses, the accurate identification of cut marks and their
associated behavioural correlates is critical to resolve the issue of carcass acquisition. Additionally, although some researchers recorded butchery marks on bones for which direct observations of butchery were made, most studies have not included exhaustive microscopic detection of cut marks (also see Milo 1994). In fact, no researchers have yet published all their data on cut mark locations and frequencies produced by certain butchery activities at particular anatomical locations. These shortcomings, among others, were the principal motivation for actualistic butchery observations made at MRM. Moreover, several authors have stressed the need for additional, detailed, well-controlled and problem oriented actualistic butchery research for translating butchery-mark data into behavioural deductions (e.g., Binford 1978, 1981, 1984b, 1988; Blumenschine 1986b; Bunn & Kroll 1986, 1988b; Crader 1984; Fisher 1995; Frison 1978; Gifford-Gonzalez 1989b, 1993; Lyman 1994b; Milo 1994, 1998; Morlan 1984).

Before observations were made at MRM, I had several unanswered questions in mind including, for example, the following: are Binford’s (1981) cut marks attributed to disarticulation always produced by this activity and do such cuts indicate the state of the carcass at the time of acquisition?; where exactly, and how consistently does a butcher cut on the distal surface of the radio-ulna in order to dismember the metacarpal from the former?; or is there an easier way to accomplish the task without impacting the distal radio-ulna at all?; how many ways are there to remove the meat from a femur, and will different methods result in bone surface damage specific to filleting only?; more problematically, I asked whether cut marks produced by filleting are ever in anatomical locations which are normally considered as areas of dismemberment?; do cut marks at articulation surfaces indicate disarticulation of elements with meat still attached to the bone or disarticulation of defleshed bones to facilitate transport and/or marrow extraction?; and do factors such as condition of carcass, type of butchery tool, size of carcass and so forth affect the frequency and placement of cut marks? Answers to these kinds of questions were not available in the literature at the time this study was undertaken. The study at MRM aimed at answering these and other butchery related questions.

Over and above the previously mentioned reasons for additional experiments in the domain of animal carcass processing, is the need for larger comparative samples. Currently, the total number of animals studied during butchery experiments is small, and considering the number and magnitude of interpretations that have stemmed from that frame of reference, it is clear that a much larger and more variable sample is required. It is from the perspective
described above that problem orientated, detailed, and well-controlled actualistic butchery observations were made at MRM. In the next chapter I describe the methods and samples employed during the actualistic butchery study at MRM.
CHAPTER 3

SAMPLES AND METHODOLOGY

3.1. INTRODUCTION

In this chapter I describe the samples and methodologies employed during the actualistic study at MRM. In section 3.2 I provide a brief description of the butcher who performed most of the butchery. Then I describe the animals and categories making up the actualistic sample in section 3.3. The methods used for recording butchery activities is explained in section 3.4, followed by a description in section 3.5 of the techniques employed for cleaning and curating the bones after they were butchered. In section 3.6 I describe the various types of butchery marks that were identified in this study as well as the methods used for examining bone surfaces for butchery damage. This is followed, in section 3.7, by a description of the methods used for recording marks and, in section 3.8, the manner in which cut marks were quantified and analysed. Finally, the methods for illustrating cut marks are described in section 3.9.

3.2. THE BUTCHER

The same person butchered most animals in the study. Adam is a man of small stature (approximately 1.6 m) and weighs about 60 kg. He is an expert butcher and processed between 3 and 10 animals per day during the study. He is right handed and mostly used his favorite knife that has a bone handle and a steel blade approximately 10 cm long. When possible, Adam used stone flakes for butchery. The stone flakes were struck from hornfels cores collected in the vicinity of the field station. Flakes consisted of a variety of forms ranging from small flakes with short cutting edges to large flakes with long cutting edges. No effort was made to produce specific stone tool forms and no flakes were retouched. Although he found working with them a bit cumbersome at the outset, he soon became proficient with stone flakes. Adam developed a preference for larger (cutting edge of 5 cm or more) stone
tools and wrapped his index finger in a piece of cloth to prevent being cut. Some butchery tasks carried out with a metal blade could not be accomplished with stone tools.

3.3. THE ANIMALS

Butchery observations were made on bovids that fall into two categories, the first being animals that were culled by meat and trophy hunters: These animals were butchered near our field laboratory and we observed and filmed the butchery processes. We had very limited control over the butchery procedures, but because the primary objective of butchery was to deflesh bones to make biltong (dried meat) and sausage, the butchery activities were consistent. In a few cases we requested the butcher(s) to perform specific tasks, such as disarticulation. We were able to obtain detailed information for constructing utility indices for a few animals in this category. The latter research is beyond the scope of this dissertation. The bones of nearly complete skeletons for most animals in this category were retained including; one Steenbok (*Raphicerus campestris*), between four and seven (depending on the skeletal elements we were able to retain) Springbok (*Antidorcas marsupialis*), one Blesbok (*Damaliscus dorcas phillipsi*), three Black Wildebeest (*Connochaetes gnou*), and three Eland (*Taurotragus oryx*).

The second category consists of animals purchased by the project and provided by our landlord and neighbouring farmers. These animals were processed according to our objectives and we retained all bones, except a few lost for unknown reasons. We made detailed butchery observations for animals in this category including information to construct a utility index for Eland. The latter work is beyond the scope of this dissertation. This category includes two Eland and one Springbok.

A few unforeseen difficulties arose during the experiments. For the culled animals these related to multi-directional communication. Quite a few people (the hunter/owner of the animal, the manager of the skinning-butchering shed, the "owner" of the labour [butcher], the butcher and his assistants, and we) had varying influence regarding the timing and manner in which animals were processed. Failure in communication caused difficulties in keeping track of dates and times of processing activities, details of activities to be carried out, and indeed of individual specimens. Nevertheless, as mentioned previously, the procedure followed for processing animals for drying meat and for the production of sausage (the way the majority
of animals were processed) is reasonably standardised, and we were able to capture valuable information.

In the case of animals culled by meat hunters, the following difficulties arose. Often the viscera, head and metapodials were removed before we reached the processing station and therefore we could not obtain body measurements. For the same reason we were unable to obtain weights for some skeletal elements. Many animals were processed at the same time so in some cases it was difficult to keep track of all the bones as they were removed; because the hunters often took some of the bones with them, we were not always able to retain all bones from an individual. Similar problems were faced when attempting to capture data from animals culled for trophies, since these animals were processed like those culled for meat. However, in most cases, all bones from an individual were retained with the exception of skulls and metapodials. From the first category we were able to obtain information and footage of the butchery process (in some cases including the use of stone flakes), dismemberment of skeletal parts, weights for different anatomical parts, measurements of the animals prior to butchery, most bones retaining butchery marks, marrow extraction processes and signatures, and weights of marrow associated with different skeletal elements.

Because we had full control of the procedures followed in processing animals in the second category, difficulties were limited and beyond our control. The main cause of complications was time constraints. Because the research team consisted of only two individuals and because we relied heavily on one of the local butchers, we were often constrained by the time he could spend working with us. Processing an eland is a major task and more daunting when processed by one person. We had to process animals within a reasonable time to avoid spoilage. Therefore, certain activities were only applied to half the animal. For example, in the case of butchering with stone flakes, the process was too slow to work the entire animal in that fashion, and therefore only half the animal was butchered with stone. Similarly, weighing every body part and bone proved very time consuming and therefore, assuming symmetry, only half the animal was weighed in that manner. Nevertheless, we were able to capture a wide range of information from animals in this category including video footage of butchery activities, the effectiveness and longevity of stone flakes used for butchery, body measurements, data for constructing utility indices, marrow extraction experiments, times taken to process various animal units and skeletal elements, and all the bones with their cut marks.
Purchased animals were processed in the following manner. Lower viscera were removed at the kill site and packaged. After transport from the veld, the animal was measured and weighed, providing a "live weight" which included all viscera. The upper viscera were removed with a metal knife. The upper and lower viscera were distributed among those who helped during the hunt. Then the animal was skinned, in some instances half the task was performed with stone flakes. Once skinned, half the animal was disarticulated (in some cases with stone flakes) according to the system used by Metcalfe & Barlow (1992) and all parts were weighed. The other half of the carcass was filleted without disarticulating any parts except for the metapodials, which were almost always disarticulated prior to or during skinning. Once all bones from a carcass were largely defleshed, they were weighed and are referred to as butchers’ bone. Later the bones were boiled (in order to remove adhering soft tissues) and weighed again after all the remaining soft tissues were removed (this is referred to as boiled bone). Once boiled and cleaned of adhering soft tissues, bones were fractured for marrow extraction. Marrow and bone were weighed separately after marrow extraction. Bones were dried, bagged and transported to Cape Town for further cleaning and degreasing. Once degreased the bones were weighed as dry bone.

For all purchased animals and some culled animals, body measurements were taken and include:

1) length of horn measured from the base to the tip along the frontal surface
2) diameter of the horn measured at its base
3) the distance between the horn tips
4) the length of the ear from the frontal base notch to the tip
5) the length of the head from the tip of the nose to the atlas joint [measurement taken along curvature of head]
6) the length of the body from the atlas joint to the base of the tail [measurement taken along curvature of body]
7) the length of the tail measured from the coccygeal-lumbar junction to the tip
8) shoulder height measured from the top of the shoulder above the scapula to the tip of the hoof [measurement taken in a straight line]
9) heart girth, circumference of the chest measured just behind the front legs
10) length of hind leg, from the point of the hock to the hoof tip [measurement taken in a straight line]

11) total length of the animal from the nose tip to the tail tip, along body curvature

3.4. RECORDING BUTCHERY ACTIVITIES

During a pilot study various butchery episodes were observed, but the bones of only two specimens were retained. The two specimens (Black Wildebeest and Steenbok) were processed for making biltong (spiced and dried meat) and for the production of sausage. Having viewed this process on numerous occasions, I realized that the procedure performed is repeated from one animal to the next. A detailed description of the procedures followed in processing these animals is described in the general observations part of Chapter 4. During the pilot study a video camera was not available, hence butchery was recorded in writing and by still photography. This is the same method Binford (1978, 1981) used for recording the butchery of animals by the Nunamiut in Alaska.

The pilot study was undertaken on a game farm in the Karoo where I investigated the feasibility of doing actualistic butchery research in South Africa. The Karoo offers a rare opportunity to observe and record the processing of game animals in a modern context. While observing the butchery process I attempted to document the activities by keeping detailed notes and taking photographs. It was soon apparent that recording a dynamic process effectively is virtually impossible using static media such as record sheets and still photography. Like many dynamic processes butchery happens fast, making it physically impossible to make notes of detailed activities and/or to photograph every step of the process without the aid of several assistants and without ceaselessly interrupting the butchery procedure. Binford experienced this problem and pointed out that "filleting was done by butcher [sic] in the field so rapidly that I did not have time to adjust my camera and take a picture before he finished making his cuts and removed the fillets" (1981:125-126). Metcalfe also stated "the first time I went with Jim (butcher) to butcher a deer was both an eye-opener and a bust. I did not get a single picture, I was only able to record about half the weights and times, and to this day I have not been able to reconstruct the entire butchering sequence for that animal. The problem was that I had absolutely no idea about how fast a skilled butcher could strip meat from a carcass or disarticulate its various elements" (1990:3). Using static media to record butchery is costly in time, energy, and materials. I realized the most effective
and least expensive medium for capturing such a dynamic process is by a "live" recording device such as a video camera.

Videography permits us to capture behaviour as it happens, and at the same time enables the researcher to capture additional information without the use of several assistants. While shooting behaviour(s) in video format, the researcher is able to make notes and observations verbally, thereby saving a considerable amount of time, and allowing activities to proceed without interruption. Furthermore, and probably most importantly, the nature of footage allows one to review the situation after the fact. Since film retains all aspects of the activity captured, many additional observations can be made after the activities have been completed. This facility makes video and/or cinematography unique as recording devices.

Video cameras, particularly camcorders, are becoming progressively advanced and affordable. The average video camera is light and compact, making it easy to transport and operate without being cumbersome and intrusive. Most cameras are equipped with a suite of standard features and I mention a few that I found particularly useful. Operating the camera in "playback" (VCR) mode enables one to assess the nature and quality of footage immediately after filming, thereby ensuring that the image portrays the desired material. The zoom facility permits one to move from medium range to close-up shots, where one can frame finer details of the activity being captured. Most modern video cameras have a digital macro feature which allows one to film objects from as close as 5mm. This provides the means to film detailed bone surface features that are not easily or effectively presented by text or still photographs. Video combines images and narration, making it an additional and in some cases a more effective medium for presenting detailed features of objects. After footage has been copied from video film onto standard VHS cassettes, the former can be reused several times, thereby reducing expenses considerably.

During butchery observations for this dissertation (July and August 1993) I filmed the butchery of several African antelope on a game farm in the Karoo. Specimens included Eland, Black Wildebeest, Blesbok, and Springbok. Video footage includes skinning, disarticulation, filleting, and marrow extraction amounting to around 18 hours of film. Most footage consists of medium range shots which portray the activity as a whole (butcher and animal), while some footage focuses on specific zones of the activity (e.g., butcher's hand, cutting tool, and anatomical zone being impacted). While filming I discovered that one can use your free hand to point at areas which are being filmed and described verbally. My assistant kept notes relating to the specimen being filmed and the activities taking place.
during the butchery process. Operating the camera required clean hands and therefore I depended on my assistant to weigh carcass parts while I continued filming the butchery process.

The date and time display on the video camera was recorded at all times to facilitate sequencing the footage at a later stage. Verbal notes were recorded on camera but consisted essentially of general observations. The playback feature on the camera enabled me to keep track of information captured as well as picture quality. Once a few films were fully exposed, they were copied onto standard VHS cassettes by use of a VCR after which the films were reused. Access to a VCR and monitor is crucial if reusing previously exposed film. The footage on each cassette was inspected and notes made including a brief description of the action and starting time of each consecutive action. Once each cassette is accompanied by a set of time-action notes, they can be re-viewed in order to make detailed observations of specific attributes of the action captured. At this stage observations of the butchery process, which are not easily (if at all) captured by still photography or written records, can be made. For example, details pertaining to anatomical locations and orientations of cutting actions are difficult to describe in any detail while butchery is in progress since the researcher is concentrating on filming the task at hand and because butchery happens so fast. Footage allows such observations to be made at leisure after the fact, where one can pause at, or replay (in slow motion if desired) actions which were particularly fast or difficult to follow in play mode. Because footage retains all aspects of the behaviour captured and not merely the attributes which a particular researcher chose to investigate and document, additional data can be recorded and extracted by other workers without repeating similar fieldwork. A feature considered important in the butchering process is the time (cost) taken to complete certain tasks (Metcalfe & Barlow 1992). Footage preserves activities as they occurred and consequently retains real time. By replaying the butchery footage, one can record times taken to execute certain tasks without the aid of assistants and without constantly interrupting the butchery process. When my assistant was not available, I saved a considerable amount of time during the weighing process by simply filming balance/scale readings and calling out the values. This prevented excessive interruption of the butchery process and I could readily retrieve this data from the footage.

During some of the marrow extraction experiments I filmed myself by placing the video camera on a tripod while my assistant completed more pressing tasks. Instead of noting all the locations and orientations of percussion points textually, I narrated these directly onto
film, along with visuals of the experiments. A great deal of time was saved, and finer details could easily be extracted from the footage at a later stage.

The former section highlights advantages of using video as a recording device, but I now turn to some of the problems faced during filming. One of the major problems involves compensating for variable light on and around the image being captured. When the image was illuminated by sunlight but shadowed in parts, the picture quality and focus were adversely affected. This problem is easily overcome by changing the camera location, orientation, and angles of shots or by creating shade on the area falling into frame. Viewing a shot prior to filming is crucial in order to ensure good picture quality. This applies across the board since poor, intense, and variable light affect picture quality to different extents and in varying ways.

Maintaining power supply to the camera can be a severe problem in the field. If "home" in the field is supplied with electricity, I advise investing in at least three battery packs (each allowing several hours of filming time). Always have a battery on charge. When electricity is not available one obviously requires additional batteries. Rechargeable batteries providing up to eight hours filming time are now available and are carried separately from the camera. Although I could operate the camera from the main power supply, this restricted camera movement and was therefore not ideal. During the first few days of filming I occasionally failed to capture the very beginning and end of an action. This is because it takes a few seconds for the film to run smoothly, and therefore, images captured during the first and last few seconds of a "take" are sometimes poor. This problem is easily overcome by allowing the film to run for ten or so seconds before "action" and after "cut". On windy days and at times of unwavering chatting by observers, the quality of sound deteriorated significantly. I managed to reduce the impact of wind quite effectively by cupping the on-board microphone with one hand. Cutting out background chatting probably requires an autocratic director. A remote microphone is an ideal solution to most background noise, particularly those coated by synthetic fur. I found zooming in and out on an image more distracting than effective. Because the human eye is not capable of zooming, such shots often appear unnatural. Nevertheless they are effective in certain circumstances. Therefore it is advisable to view the shot a few times before filming. A more pleasing image is created by shooting the image from a medium range, pausing, taking the camera to the image and continue filming. If the camera is closer than about one meter from the image, it is best to take the camera up to the image rather than to zoom. This is because some camcorders have problems zooming at close
range and therefore the picture becomes distorted and unfocused. Furthermore, I found that macro shots are almost always considerably more crisp and stable than zoom shots. A potentially disastrous problem concerns erasing or filming over exposed films. All films should be clearly labeled once exposed and labels removed once footage is copied onto standard VHS cassettes. Footage that is selected for later editing should be retained on the original video film since much quality is lost with every generation from the original.

Although courses are available, filming, like many practical skills is best learnt by repetition and experience. Accommodating for variable light while moving around with the camera, for example, is a major but not insurmountable obstacle. Similar difficulties are overcome with practice, experience, and knowledge of the capacities and limitations of the camera. When filming excavations or other material, it is probably best to do so personally since you know what is important and what you want to see. Moreover, learning to use a video camera is more elementary than teaching a cinematographer to think like an archaeologist.

Before and while writing Chapter 4 I spent numerous hours reviewing video footage of butchery in order to dictate and take detailed notes of different butchery activities. I was also able to see where different butchery actions were likely to impact bone. Without video footage of the butchery observations the descriptions in Chapter 4 would have been much less detailed and incomplete.

3.5. CURATION OF BONES

Before bones from various carcasses collected during the actualistic studies could be examined for damage produced during butchery, they were cleaned according to the South African Museum (SAM) standards for museum curation. The bones collected during the pilot study in 1992 were cleaned somewhat differently from the bones collected during 1993. I will describe both cleaning methods since readers may find the alternatives useful. One method is much less time consuming while the other is less expensive.

Bones collected in 1992 were initially soaked in cold water for two days and then boiled until adhering flesh, tendons, and cartilage could easily be removed by brushing with a tooth- or nailbrush. Adding some washing detergent to the boiling water facilitated the softening of tissues adhering to bones. While still at boiling point, but with the hot plate off, some sodium perborate was added to the surface of the water. This chemical further facilitated the
softening of tissues and degreasing the bones. Once the water had cooled, bones were removed and brushed clean (the use of metal objects was avoided to prevent the production of pseudo cut marks). All hyaline cartilage was removed by brush. Ensuring that no cut marks were being impacted, small holes (some 1.5 mm in diameter) were drilled near each of the epiphyses of the long bones. These holes encouraged marrow and grease within the marrow cavity as well as trabecular bone to escape more readily. Bones were then placed in trichloroetheline for approximately two weeks to complete the degreasing process. Once degreased, bones were soaked in a solution of hot (not boiling) water and Ammonia in order to remove excess trichloroetheline. Bones were removed from the latter solution after about 24 hours after which they were rinsed in water for another two days before being bleached in a weak solution of hydrogen peroxide and water. After removal from the latter solution, bones were dried slowly at room temperature to avoid warping. At this point the bones were completely degreased and white. Cleaning and degreasing the bones of one black wildebeest required approximately four weeks.

Bones collected in 1993 were cleaned over a period of sixth months. While in the field, all bone-cleaning activities were performed outdoors. Fortunately, the Eland specimens were intermittently spread over our two-month field season, so cleaning one at a time or along with a smaller specimen was manageable while continuing more pressing work. Due to the size of Eland bones, we made special cooking pots from a forty-gallon drum. The drum was sawn in half, leaving two vessels of the same size. Holes were drilled and handles made of thick wire and pieces of hosepipe were fitted. The drums were either placed over an open fire, or atop a small electric stove. Thanks to Mr. Rau, I was fortunate to use the Taxidermy department's facilities at the SAM to clean the bones from the larger animals. Before the bones were cleaned, they were weighed as butcher's bone. The objectives for weighing individual bones as butcher’s bone are described earlier in this chapter.

Before bones from the 1993 collection were cleaned, the bone surfaces were thoroughly examined with a binocular microscope. Initially bones were boiled for several hours, or until the adhering soft tissue could easily be removed by hand or with a nylon bristled nail- or toothbrush. To avoid creating and later recording pseudo cut marks, all epiphyseal and articular surfaces were thoroughly inspected with a binocular microscope before removing the hyaline cartilage with a dental spatula. All other bone surfaces were readily cleaned with a nylon bristled nail- or toothbrush. After the surfaces were cleaned of hyaline cartilage, I inspected the surfaces with a binocular microscope and found that the dental spatula did leave
marks. The latter, microscopic marks, are readily distinguishable from cut, scrape, and shave marks produced by metal or stone butchery tools. After the bones were thoroughly cleaned of soft tissue, they were rinsed in clean water and left to dry at room temperature and away from direct sunlight to avoid warping and shrinkage. Unlike the bones from the 1992 collection these bones were not drilled to extract remaining marrow and/or grease. The bones were never soaked in trichloroetheline, sodium perborate, ammonia, or hydrogen peroxide and some bones, particularly those of the eland, are still somewhat greasy. Once the bones were thoroughly dry they were labeled. The area of the bone to be labeled was examined thoroughly using a binocular microscope to ensure that no surface modification would be affected. Labels were written with black indelible ink. The bones were finally packaged according to curation guidelines set out by the South African Museum and are currently housed in the same institution.

### 3.6. IDENTIFYING BUTCHERY MARKS


Several types of cut marks were identified while examining the experimental sample including:

1. incisions made perpendicular to the bone surface [cut mark]
2. incisions made at an angle to the bone surface [slice mark]
(3) cut and shave marks (the knife shaves a portion of the bone after an incision is made) [cut/shave mark]

(4) shave and cut marks (the knife blade shaves a potion of bone before it bites into the cortical surface) [shave/cut mark]

(5) cut and shave and cut marks (the knife makes an incision into cortical bone then shaves a portion of the bone after which it penetrates the cortical surface) [cut/shave/cut mark]

(6) shave and cut and shave (the knife shaves a portion of the bone surface, then cuts into cortical bone and again shaves a portion of cortical bone) [shave/cut/shave mark]

(7) shave marks (the knife blade is used at an acute angle to the bone surface and is moved in a direction perpendicular to the length of the blade causing a portion of cortical bone to be shaved away - often leaving fine striations within the shaved area which are mostly perpendicular to the long axis of the shave mark – the fine striations are caused by slight back and forth movements of the knife blade while the shave is being made) [shave mark]

(8) scrape marks (the knife blade is held perpendicular to the bone surface and is moved in a direction perpendicular to the length of the blade – no part of the cortical surface is shaved away, but fine striations which are perpendicular to the long axis of the scrape mark are produced due to irregularities along the knife blade) [scrape mark]

(9) punctures (the point of the knife blade punctures the bone surface) [puncture mark]

(10) puncture and drag marks (the point of the knife blade penetrates the bone surface and then the knife is pushed or drawn away from the puncture leaving an incision connected with the puncture) [puncture/drag mark]

(11) saw marks (made with either electric or hand held metal saws) [saw mark]

(12) crushed or damaged bone (caused mostly during disarticulating the ribs from the thoracic vertebrae – often a portion of bone is cut away, exposing trabecular bone) [crush mark]

(13) incisions made at indeterminate angles to the bone surface [incision]
(14) nicks and notches (usually produced at the edges of bones where the knife blade punctures the bone surface, leaving a nick or notch where the bone was pierced or cut away) [nick/notch mark]

(15) puncture, shave and cut marks (the knife point penetrates the bone surface after which a cut and shave (see type 3 above) or shave and cut (see type 4 above) mark is produced) [puncture/shave/cut mark].

Once the bones were clean, each specimen (1501 bones) was examined with a binocular microscope under low incident light. Magnification from 6 to 40 X was used, but the majority of cut mark identification and location was conducted at 8 X while higher magnification (up to 40 X) was used in very few instances, particularly when marks were obscure and/or not readily identifiable. I found that higher magnification made cut marks more difficult to identify and distinguish from other surface modifications in that their internal morphology became unclear. A case of, the closer you look, the less you see. See Blumenschine et al. (1996) for a discussion of this issue.

After cut marks were located, each was circled with a fine permanent black marker. This decision was taken so that cut marks could easily be located during documentation and future research and more importantly, it ensured that the bones were examined twice. The bones were initially examined for identifying and locating cut marks and re-examined while details of individual cut marks were recorded.

3.7. RECORDING BUTCHERY MARKS

Once butchery marks were located and circled, various features of individual cut marks were recorded on photocopies of various skeletal elements. The latter facilitated accurate placement of cut marks. Bones were viewed for a second time and all additional cut marks were marked and recorded. Various features of individual cut marks were recorded but here I focus on anatomical placement, orientation and angulation.

The location of marks was recorded on photocopies, so the anatomical placement of each mark is accurately reflected by its position on the photocopies of various skeletal elements. The orientation of cut marks is obvious from the orientation of lines (relative to the long axis of bones) representing them. Orientation indicates the manner in which the blade of the
cutting tool was held during butchery. The orientation of shave or scrape marks is often unclear, but can be determined in some cases. The depressed area of a shave mark is often marked by multiple microstriations that, in most cases, are perpendicular or oblique to the orientation or long axis of the shave mark. In other words, the blade of the tool was oriented at right angles to the shave mark, but the orientation of the shave mark indicates the trajectory of the butcher’s hand.

Angulation refers to the angle at which the butcher's tool penetrates the bone surface. The angle of a cut was measured relative to the bone surface and not relative to the orientation of the bone. The angulation of a cut mark indicates the direction from which the butcher worked, but not the direction in which the blade was pushed or drawn. Angulation also indicates whether a cut was made along or into the bone surface. Angulation of cut marks was recorded by using different colors to represent various angles. When documenting the angulation of cuts, it is crucial to maintain the same orientation of the record sheets for a particular skeletal element.

3.8. QUANTIFICATION AND ANALYSIS OF BUTCHERY MARKS

Cut marks were counted or tallied as individual marks regardless of the type of mark. Closely spaced marks were not counted as single marks as is done by certain researchers (e.g., Lyman 1992), but were counted separately. This was done because the present author, along with other researchers (e.g., Milo 1994), believes that the number of marks is indicative of the intensity of butchery activities. The higher the number of marks, the more effort was expended in a specific butchery procedure. If closely spaced marks are counted as one, then it is not possible to gauge the intensity of butchery effort. The only time that a group of more than one incision or slice is counted as a single mark is when they occur as part of a scrape or shave mark. In all other cases, each mark was tallied as a separate entity.

Once cut marks were recorded on photocopies they were coded and entered into Microsoft Excel (Windows ’95) and digitized using ArcView (Version 3.1). Three separate but related databases were created. All databases contained the bone number of each specimen that acted as the identity number, making the databases relational. The first two databases were created in Excel. The first database (Animal and Bone Data) contains information regarding the animal and bone specimen, and includes the bone number, group number, species, size class, side, skeletal element, butchery activity, and butchery tool. Codes
for the latter database are presented in Appendix A. The second database (Cluster Data) contains information regarding clusters of butchery marks and includes the bone number, cluster number, number of butchery marks, orientation of cluster, orientation of butchery marks, view from which butchery marks are visible, anatomical portion, anatomical location, butchery activity, and priority of butchery marks. Codes for the latter database are presented in Appendix B. The third database (Cut Mark Data) was created using the Geographical Information System (GIS) package, ArcView (Version 3.1). Butchery marks were digitized from the photocopies and more detailed information pertaining to each mark was entered, including type, orientation, and angulation of individual butchery marks. Codes for the GIS database are presented in Appendix C.

After all cut marks on the photocopies were entered, the three databases were joined. ArcView was used to create images containing the spatial location of cut marks on each skeletal element. Separate files were created for different butchery activities. For example, one ArcView file contains the spatial location of cut marks on large bovid femora produced during filleting, while another contains the spatial location of cut marks on large bovid femora produced during filleting and disarticulation. By overlaying the ArcView files with scanned images of skeletal elements I created the figures presented in Chapter 4. The generation of these figures is described in more detail below. While ArcView was used for the visual analysis and presentation of data, Microsoft Excel was used for generating the frequency distributions of cut marks presented in the tables in Chapter 4. The composite database (All Information) was sorted according to animal size class, skeletal element, and priority of cut mark, and separate spreadsheets created for each. For example, one sheet within the All Information spreadsheet contained all information of cut marks related to the femora of small bovids, while another sheet contained all information of cut marks related to the femora of large bovids. These sheets were used to generate frequency distributions (presented as raw data and percentages) of cut marks for individual skeletal elements by animal size class as presented in the tables in Chapter 4. To compare the frequency of cut marks on small and large bovid bones I applied the Mann-Whitney $U$-test as described by Sokal and Rohlf (1981: 392-394). Where $n_1 > 20$, $t_s$ was calculated.
3.9. ILLUSTRATING BUTCHERY MARKS

Firstly, photographs were taken of various views of all skeletal elements of a Black Wildebeest (*Chonnochaetes gnou*). Photographs were then scanned and written to Compact Disc (CD) as TIF files. Using Photo House (Corel 8) the photographs were cleaned, edited and saved as JPEG files (this decreased their size significantly). The latter were imported into Freelance Graphics (Version 2.1) where they were edited further and saved as Freelance presentation files. The latter were used as templates for generating the figures in Chapter 4. The final version of the figures were completed in Freelance by opening the template (presentation) files, importing the ArcView (WMF) files, and overlaying the two to create composites. Once the figures were complete they were written to CD since they occupied over 1000 MB on the hard drive. A compact disc copy of the figures is housed at the South African Museum with Dr. Graham Avery.

The reader may note that some of the cut marks are not in precisely the same location where they are repeated in different figures. The latter is the result of overlaying and sizing by eye and hand. The margin of error is inconsequential and does not detract from the overall results or interpretations. Although only left skeletal elements are presented, the figures in Chapter 4 include cut marks on both left and right elements. Cut marks occurring on right elements were simply flipped horizontally and overlaid on left elements. This was done to reduce the number of figures in the dissertation and to avoid a reduction in sample size.

In the next chapter I present a detailed account of the results from butchery observations at MRM.
CHAPTER 4

RESULTS FROM ACTUALISTIC BUTCHERY OBSERVATIONS

4.1. INTRODUCTION

Observations made during actualistic research in the Karoo are presented in this chapter. Due to sample size and for comparison with Bunn and Kroll (1986), data are described by bovid size classes I and II (small bovids) and bovid size classes III and IV (large bovids) rather than by individual size class. A further reason for lumping size classes I and II is that these animals are similar in their anatomy with respect to the strength of joints, muscle and ligament attachments. For more detail on natural disarticulation of skeletal elements due to the strength of different joints see for example Binford (1981) and Hill (1979a, 1979b, 1980). The same assumption is made for lumping size classes III and IV. The difference in effort put into butchering small and large bovids (in terms of numbers of cutting actions and times taken to complete butchery activities) indicates that there is a significant difference in the strength of joints, muscle and ligament attachments between small and large bovids. Because of this, the two size groups are separated in this study. Lyman (1987a) has suggested that joints differ in strength and that stronger joints are likely to require more butchery effort (time and cutting strokes) during disarticulation than weaker joints. The first group (small bovids) consists of animals in size classes I and II, while the second group (large bovids) includes animals in size classes III and IV (e.g., Brain 1981; Bunn 1986). The small bovid category comprises Steenbok (*Raphicerus campestris*) and Springbok (*Antidorcas marsupialis*) and the large bovid category includes Blesbok (*Damaliscus dorcas phillipsi*), Black Wildebeest (*Chonochaetes gnou*), and Eland (*Taurotragus oryx*).

This is a documentary chapter in which I describe butchery procedures based on observations made during at least thirty butchery episodes. My descriptions of butchery activities and their associated cut marks rely strongly on video footage recorded during the actualistic study. Video footage was reviewed numerous times to document details of butchery activities. Procedures employed for butchering small and large bovids are described
separately although there are similarities. If butchery activities were the same for large and small bovids, a full description is given for small bovids. An abridged version is given for large bovids, but where differences in butchery were observed a full description is given for large bovids as well.

First I describe general observations of butchery procedures in section 4.2. Butchery procedures include evisceration, skinning, disarticulation, and filleting. Bone by bone descriptions start with the axial skeleton (section 4.3) from the cranium to the mandible, atlas, cervical vertebrae, thoracic vertebrae, lumbar vertebrae and end with the sacrum. Then I describe butchery procedures applied to the appendicular skeleton (section 4.4), starting with the front limbs from the scapula to the humerus, radius, ulna, and ending with the carpals. This is followed by descriptions of butchering the rear limbs, starting with the pelvis through the femur, tibia, patella, and ending with the tarsals. Metapodials, phalanges and sesamoids are excluded from this study because no meat is associated with these elements and therefore cut marks on them are most likely the result of either disarticulation, skinning or periosteum removal or a combination of these activities (e.g., Binford 1981: 140 and 142). Finally, the butchery procedures and their associated butchery marks concerning the processing of ribs are described in section 4.4.11. For ease of comparison, butchery activities and their resulting cut marks are described for both small and large bovids by skeletal element.

Throughout my descriptions I refer to figures of the appropriate skeletal elements where cut marks were produced by specific butchery activities. The reader will notice that two or more activities are implicated in numerous figures. This is due to the fact that more than one butchery activity was often carried out while processing certain skeletal elements. The reader is therefore urged to read the text describing butchery activities and their resulting cut marks in order to tease out those marks which can be attributed to single activities. In section 4.5.2 I present figures displaying cut marks with unambiguous behavioural correlates as listed in Table 4.37. Figures 4.1 to 4.235 (Volume 2, Appendix E) are intended to be viewed in accordance with the text and not to be self-evident. I also present a figure for each skeletal element which displays cut marks produced by all butchery activities. These figures show the overall location and orientation of butchery marks and how perplexing a palimpsest of marks is when we can not separate cut marks according to specific butchery activities.

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1 Evisceration = the removal of upper and lower viscera. Skinning = the removal of skin. Disarticulation = dismembering articulated skeletal elements. Filleting = the removal of flesh.
Tables furnishing frequency distributions of cut marks at different anatomical locations and/or portions as produced by various butchery activities are also presented. Tables labeled (a) present number of cut marks and tables labeled (b) present percentages of cut marks per butchery activity at specific anatomical locations or portions. Percentages were calculated in this manner to show the reader the distribution of cut marks at various anatomical locations as produced by specific butchery activities. Values in the tables represent individual cut marks and not clusters. In the tables, activity equals butchery activity and portion equals anatomical portion or location, while values in parentheses to the right of butchery activities denote the number of bones included in the analysis (Minimum Number of Elements = MNE). In the case of carpal and tarsal bones, I used the number of carpal or tarsal sets\(^2\) as opposed to the actual number of carpal or tarsal bones. The counts of carpal and tarsal bones are given in the text and figures. Summary tables are provided in section 4.5.3 where small and large bovids are compared. Figures in Appendix D show the anatomical portions and locations referred to in the text and tables. Figure D.27 displays graphic representations of different types of cut marks as defined in section 3.6 of chapter 3.

The last part of this chapter includes presentations of selected data and brief discussions of observations and results (section 4.5) stemming from this actualistic study. Issues discussed are directly relevant to current trends in faunal and butchery studies, specifically regarding the reconstruction of human and hominin subsistence strategies based on the analysis and interpretation of butchery marks. Section 4.5.1 examines the relationship between butchered bones and the frequency of butchery-marked bones. The anatomical placement of cut marks with unambiguous behavioural correlates are presented and briefly discussed in section 4.5.2. In section 4.5.3 I present a summary comparison between small and large bovids, including details of variation in cut mark frequencies between the size groups. After a brief overview, bone by bone comparisons are made. Clearly there are adequate observations to make more detailed comparisons, but since this dissertation focuses on testing current assumptions for interpreting cut marks at certain anatomical locations, comparisons are restricted to general similarities and differences. By examining the text, figures, and tables more closely the reader may make more detailed comparisons. In section 4.5.4 a few comments are made regarding metal versus stone tool butchery. Disarticulation and filleting as well as evisceration as indicators of carcass acquisition strategies are discussed in sections 4.5.5 and 4.5.6 respectively.

\(^2\) For example, one set of carpal bones consists of one of each of the following bones; lunate, magnum,
4.2. BUTCHERY PROCEDURES

4.2.1. Evisceration

Evisceration involves the removal of organs from the abdominal cavity. This process most commonly occurred before disarticulating the cranium and metapodials and before skinning. With the animal lying on its back or side, a longitudinal incision was made on the ventral surface of the body behind the distal ends of the last ribs and behind the last sternebra. The belly sheet was most readily pierced since at this point since this is where it is most taut. After the belly sheet was pierced, the knife blade was inserted upside down into the perforation. A short cut was made by pulling the knife up, and the fore and index fingers were inserted with the palm of the hand facing up. The fingers were used to raise the belly sheet and to guide the knife in a straight line toward the crotch. The knife was held upside down to avoid piercing the stomach. Fluids from the latter render surrounding edible tissues acrid and unpalatable. The cut was extended caudally to the pubic symphysis and cranially to the last sternebra. In some cases the sternum was split longitudinally to facilitate removal of the upper viscera. Splitting the sternum was achieved by holding the knife in a ‘stabbing’ grasp, inserting the blade with the cutting edge to the front of the animal, and applying short pulling actions cranially. In some cases the upper viscera were removed without splitting the sternum.

Overall, the lower viscera were pulled from the thoracic cavity by hand and only a few cuts were made in the vicinity of the centra of the thoracic and lumbar vertebrae to free the lower viscera. The rear portion of the lower viscera was cut free from the vertebral column by making a few longitudinal to diagonal cuts in the vicinity of the ventral surfaces of the sacral centrum.

When removing upper viscera, the knife was used to cut through the membrane of the diaphragm. The organs were freed by making diagonal to longitudinal cuts relative to the long axis of the axial skeleton along the medial surfaces of ribs. Cuts were made from front to back. Cutting was common near the distal, middle, and proximal shaft of ribs (see evisceration figures referred to in section 4.4.11). No meat is associated with medial surfaces of ribs, particularly below the angle of ribs, and therefore longitudinal to diagonal cut marks

unciform, pisiform, scaphoid, and cuneiform.

3 Upper viscera: includes the heart, lungs, liver, kidneys, and other vital abdominal organs.

4 Lower viscera: includes the stomach, intestines, and other non-vital abdominal organs.
(relative to the long axis of the axial skeleton) on these surfaces are unequivocally the result of evisceration. Transverse, diagonal, to longitudinal slices to free the upper viscera were also made on ventral surfaces of the centra, particularly on thoracic vertebrae (see evisceration figures referred to in section 4.3.5). Longitudinal cuts along ventral surfaces of cervical vertebrae were made to loosen the organs of the throat. Numerous slicing motions were applied before the upper viscera were freed as a unit by pulling the organs of the throat up and to the rear of the animal.

4.2.2. Skinning

Skinning may take place either before or after evisceration, but in my observations it most commonly occurred after evisceration. Disarticulation of the head was commonly completed before skinning commenced. Skinning was initiated on the ventral side and completed on the dorsal side of the animal. An assistant held the animal while the butcher proceeded with skinning. This prevented the animal from shifting around when force and leverage were applied.

With the animal lying on its back, initial penetration of the skin was made on the ventral surface behind the last ribs. A longitudinal incision was made to pierce the skin with the point of the knife, working from cranial to caudal. The incision was started here because this is where the belly skin is most taut and therefore most readily pierced. This incision was extended cranially to the anterior part of the neck, just behind the skull, and caudally to the anus. The skin was worked loose from subcutaneous tissues by holding a loose piece of skin - on either side of the initial cut - in one hand and making longitudinal slices between skin and underlying soft tissues. The knife blade most commonly cut against the interior surface of the skin but at a shallow angle to prevent piercing it and to avoid penetrating the stomach wall and other muscles. After a small area adjacent to the initial longitudinal cut was skinned, the loose piece of skin was held in one hand while a fist was inserted and rolled\(^5\) between the skin and underlying soft tissues. In this way much of the skinning process was accomplished by fisting – pulling the skin with one hand and fisting it free with the other. Fisting was very seldom observed during the skinning of large animals. It appeared that the skin of large animals adheres more strongly to underlying tissues than that of small bovids and was therefore freed by a combination of cutting and pulling.

\(^5\) This action is referred to as fisting.
On reaching the limbs, the butcher proceeded in the same fashion as when the metapodials were disarticulated. Disarticulation of metapodials is described in more detail below in sections 4.4.5 and 4.4.10. Circular, transverse cuts were made to the carpals/tarsals, cutting through skin and connective tissues. The metapodials were snapped and turned loose, exposing connective tissues, which were cut to free the extremities. This action created the second location from where skinning could proceed. The sliced skin at the carpals/tarsals was lifted away from underlying soft tissues on the medial side of the limbs after which the knife point was inserted with the blade facing away from the underlying fascia. Once a short cut was made toward the belly, the index and middle fingers - with the palm facing away from the limb - were inserted between skin and underlying tissues so that the knife point could be readily inserted and guided. A series of these short cuts were made down to the point where this incision reached the initial longitudinal cut along the belly. On the medial sides of the limbs, the skin adhered quite firmly to underlying tissues and the knife was used to work it free. However, the bond between skin and underlying fascia on the lateral sides of limbs is much weaker and the skin was worked free by pulling and fisting. The skin along the dorsal surface of the animal along the vertebral column and in the region of the sternum, groin, and the anus also adhered firmly to underlying tissues. In these areas the skin was most readily freed by knife. The skin around the neck was freed by fisting. After one half of the animal was skinned, the skin was stretched out and the animal rolled onto it before skinning the other half proceeded. The only point at which the butchery tool made contact with bone was at the extremities of limbs (distal tibia and distal radio-ulna), the carpals/tarsals, the mandible, and the cranium. The locations of these cuts are described in the bone by bone accounts below.

4.2.3. Disarticulation

When animals were processed for drying meat and for making sausage, bones were always filleted in articulated form. The lack of disarticulation in this study results from the absence of transport constraints. This strategy of non-disarticulation may not be characteristic of mobile hunter-gatherers. Disarticulating limbs and parts of the axial skeleton was performed on some animals at my request for purposes of establishing utility indices and to gain an understanding of the disarticulation process. Unless noted otherwise, appendicular elements were disarticulated with flesh attached while axial elements (except mandibles) were disarticulated after filleting. The sequence in which disarticulation procedures are
described below in the bone by bone account does not imply butchery sequence unless stated otherwise. Butchery procedures apart from disarticulation are described in the sequence they normally occurred during butchery observations. See text, figures, and tables below for more detailed descriptions and presentations of disarticulating various skeletal elements. Here I give an overview of the disarticulation process.

Generally, the first elements to be disarticulated were metapodials, which were often removed as part of the skinning process. The animal was easier to butcher after the metapodials were removed since they hindered the butcher. Transverse and circular cuts were made to the carpals/tarsals and the elements were snapped and turned loose, exposing connective tissues. The metapodials were then readily removed by a few cutting strokes through connective tissues. Next the skull was disarticulated. This was achieved by making transverse cuts between the skull and the atlas. The forelimbs were removed by cutting connective tissue and a few lean muscles between the rib cage and the medial surface of the limbs. No cut marks are produced during this process. The rear limbs were disarticulated by splitting the pelvis at the pubic symphysis and cutting into the sacro-iliac joint to free the pelvis from the sacrum. Further disarticulation was carried out on some animals according to my objectives, but these are described in more detail below for specific skeletal elements.

Disarticulation always required cutting strokes made transverse to the long axis of joints and with the cutting edge held more or less perpendicular to joints, but not necessarily to bone surfaces, particularly articular surfaces. Since all appendicular elements were disarticulated with meat still adhering to bones, the butcher levered the bones to locate joints and also felt for the joints by hand. In some cases the butcher was not able to cut directly to joints or between articular surfaces as meat impeded his view. If bones were disarticulated after filleting, the butcher would have been able to cut directly between articular surfaces since these would have been visible. Axial elements (except mandibles) were disarticulated after meat was removed and therefore cutting strokes were made directly between articular surfaces and to joints and their connective tissues.

4.2.4. Filleting

Filleting always commenced after evisceration and skinning. Sinuous sheaths covering muscles were always removed before filleting although thin membranes encasing individual muscles were left intact. Since methods employed for filleting varied from one skeletal
element to the next, the reader is urged to see the filleting sections for various skeletal elements below. Tenderloins and sirloins were almost always the first muscle groups removed. Often the rear limbs were defleshed while still articulated to the axial skeleton. In contrast, front limbs were always disarticulated before filleting since the meat on the medial surfaces of the upper front limb is not accessible while the limb is still attached to the thorax. Filleting almost always followed the lines of membranes separating individual muscles and consequently muscles were removed in tact. Where muscles were considered too large or thick to be dried whole, they were cut into thinner strips before salting, marinating, and hung to dry. Preparing meat for sausage entailed reducing chunks of meat into small cubes before spicing and mincing.

4.3. AXIAL SKELETON

4.3.1. CRANIUM

4.3.1.1. Small Bovids

Only one skull was retained after butchery observations, but descriptions of butchery processes are presented to provide some impression of the placement and frequency with which cut marks may occur on crania. The sample is too small to be definitive, but a few generalizations are made. Although I managed to obtain just one cranium, I observed several episodes of skinning, tongue removal, disarticulating the skull from the atlas, and disarticulating mandibles from crania. Figures 4.1 and 4.2 display cut marks produced by all butchery activities.

4.3.1.1.1. Skinning

When the skin and skull were prepared as a trophy, the skin was removed prior to disarticulating the skull to keep it in one piece and to avoid staining it with blood. The skin was removed, salted, and spread out soon after the animal was killed to prevent ‘hair slip’. The latter involves hair loss, which occurs if animals are not skinned soon after death. When the skin was not processed for tanning, it was removed after the head was disarticulated. Disarticulating the head prior to skinning facilitated the latter activity by creating more access points from where the skin could be lifted and worked free. The skinning incision running
along the midline of the body on the ventral surface was extended to the mental symphysis. For more detail on skinning see section 4.2.2 above.

In the first scenario the skin was worked loose from the rear and ventral surfaces of the skull and mandible by making incisions between the skin and underlying soft tissues with the blade of the butchery tool held at an acute (shallow) angle with the bone surface, and diagonal to transverse with respect to the long axis of the axial skeleton. Most cutting was against the inner surface of the skin, severing subcutaneous tissues\(^6\) that bind skin to underlying tissues. Skinning actions moved progressively toward the front and dorsal surfaces of the cranium. When skinning for a trophy, great care was taken to remove the skin in tact without piercing it. Eye lids, lips, ears, and nasal passages were meticulously skinned out.

In the second scenario the skin was worked loose from the rear to the front, but because there were more access points, skinning proceeded from either the ventral, dorsal, left-, or right-hand sides. Sometimes a combination of the latter was used. The skin was worked loose by applying cuts between skin and underlying tissues. Cutting was mostly against the inner surface of the skin. The blade of the butchery tool was generally held at an acute angle with the underlying bone and/or fleshy surface, and diagonal to transverse with respect to the long axis of the axial skeleton.

When the skin was not prepared as a trophy, it was removed more rapidly and the skin was accidentally pierced in several places where skinning was more difficult (e.g., the eyes, lips, nasal passages, and ears). At some locations on the skull, very thin layers of soft tissue lie between skin and bone and it is in these areas where the butcher is most likely to impact bone. Cranial bones comprising these areas include the dorsal parts of the premaxilla in the region of the naso-maxillary notch, the nasal, upper maxilla, lacrimal, frontal, and anterior to lateral portions of the parietal. Portions of the frontal bone at the base of the horns are particularly prone to sustaining butchery damage, as it appeared difficult to loosen the skin at this location without making contact with underlying bone. Figures 4.3 and 4.4 display the locations at which skinning marks were produced. Cut mark types produced during skinning include cut marks and slice marks\(^7\). Table 4.1. indicates that skinning marks are most

\(^6\) Throughout this dissertation I used Sisson and Grossman (1953) for anatomical terminology except where more common terms were used.

\(^7\) For definitions of cut mark types see section 3.6 in chapter 3.
common on the parietal and frontal bones. Only one skinning mark occurs on the nasal/maxilla.

4.3.1.1.2. Disarticulating the cranium from the atlas

If the skin and skull were prepared as a trophy, the skin was removed prior to disarticulation of the skull to keep it in tact and to avoid staining it with blood. Nevertheless, disarticulation of the skull was carried out in the same manner during all butchery episodes I witnessed. Disarticulation was initiated by making transverse cuts through skin and flesh on the ventral surface of the neck directly behind the ascending ramus and coronoid process. These cuts were made toward the articulation between the atlas and the occipital condyles. Force was used to lever the head backwards, thereby exposing the articulation between the skull and atlas. Very few transverse cutting actions between the occipital condyles and the cranial articular surfaces of the atlas were required to disarticulate the head. In some cases transverse cuts were made to the dorsal surface of the articulation between the atlas and the skull after the head was levered back and forth to tear, stretch, and expose connective tissues and articular surfaces. The locations of disarticulation marks are presented in Figure 4.5. Cut mark types include cuts, shave/cuts, and a shave mark. Table 4.1. shows that all cut marks associated with disarticulation are located on the occipital condyles.

4.3.1.1.3. Filleting

In small bovids, minor quantities of meat are associated with the bones of the cranium. Most of the edible tissue consists of the brain, nasal tissues, and the eyes. Hardly any filleting of the cranium took place during my butchery observations. The only activity associated with filleting the skull was the removal of the masseter muscle. The latter was severed just above the upper molar row at the base of the maxilla – roughly above the rear three molars. The butchery tool was held perpendicular to the bone surface and cutting motions were longitudinal with respect to the long axis of the axial skeleton. After the masseter was severed and the mandible disarticulated from the skull, the butchery tool was held at an acute angle with the bone surface and the muscles were shaved from the skull. The butchery tool was held transverse to diagonal to the long axis of the axial skeleton, but the actions of the butcher’s hand were longitudinal to the axial skeleton. None of these shaving actions left microscopically visible traces on the bone surface. After these muscles were removed the
skulls were boiled and the remaining meat was eaten piecemeal after it had softened. Soft tissues were scraped, cut, or eaten directly from the bone. No cut marks were produced by removing the masseter muscles or by filleting.

4.3.1.1.4. Disarticulating the mandible from the cranium

This activity is described below in section 4.3.2.1.4. No cut marks were produced on the cranium.

Table 4.1. Frequency distribution of cut marks on small bovid crania. D = disarticulating, S = skinning, NM = nasal/maxilla, OC = occipital condyle, PA = parietal, FR = frontal.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Portion</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>D (1)</td>
<td>0/9/0/0</td>
<td>9</td>
</tr>
<tr>
<td>S (1)</td>
<td>1/0/7/6</td>
<td>14</td>
</tr>
</tbody>
</table>

4.3.1.2. Large Bovids

Activities observed during butchery of crania include disarticulating the skull from the atlas, skinning, tongue removal, disarticulating the mandible from the skull, and filleting. Figures 4.6 and 4.7 display cut marks produced by all butchery activities.

4.3.1.2.1. Disarticulating the cranium from the atlas

Unless the skin and skull were prepared for trophies (see description above in section 4.2.2), this activity was performed before the skull was skinned and processed. Transverse cuts were made to the ventral surface of the neck towards the articulation between the occipital condyles and the cranial articular surfaces of the atlas. These cuts were made just
behind the ascending ramus. Having cleaved the flesh, and on reaching the area of articulation, the butcher extended the transverse cuts to either the left or right side of the neck, and cut toward the articular surfaces between the skull and atlas. Sometimes the knife point was inserted between articular surfaces to sever connective tissues. The transverse cuts were also extended to the dorsal surface where cuts were made toward articular surfaces. After some connective tissues were severed, the head was snapped and twisted to one side (usually away from the side to which cuts were made) which stretched and tore connective tissues. Then additional transverse cuts were made to sever connective tissues after which the head was snapped and twisted to one side again. The skull was then severed from the neck by a few more transverse cuts through connective tissues and flesh. Cut mark types include cuts and slices. Figures 4.8 and 4.9 show cut marks produced during disarticulation. Cut marks are restricted to the occipital condyles and paramastoid processes. Most marks are transverse to the axial skeleton. Table 4.2 indicates that the majority of disarticulation cuts are located on the occipital condyles while a few are present on the paramastoid processes.

4.3.1.2.2. Skinning

Procedures employed for this activity were roughly the same as those used for small bovids as described above in section 4.3.1.1.1. However, instead of skinning from the rear and caudal part of the skull, as was done with small bovids, the skin was worked loose from the dorsal and cranial part towards the ventral and front of the skull. The skin was first loosened around the base of horns and then worked loose ventrally and cranially. Considerably more cutting actions were employed for large bovids, particularly around the base of horns. The butchery tool was often turned around and used from a variety of angles and directions. Cutting actions were predominantly diagonal to longitudinal with respect to the long axis of the axial skeleton although several transverse cutting actions were observed. Cut mark types produced during skinning include cuts and slices. No shave/cuts, shaves, or punctures were recorded. Skinning cuts are displayed in Figures 4.10 and 4.11. Figures 4.12 and 4.13 display cut marks produced by either skinning or filleting. Having reviewed the butchery footage, it is clear that the cut mark on the maxilla in Figures 4.12(b) and 4.13(a) was produced by skinning, but cut marks on the premaxilla in the same figure can not be attributed to a single activity. Table 4.2 shows that skinning cut marks are most numerous on the frontal, followed by the parietal. Fewer marks are located on the nasal, nasal/maxilla,
nasal/lacrimal, and maxilla. No skinning marks were recorded on occipital condyles or paramastoid processes.

### 4.3.1.2.3. Disarticulating the mandible from the cranium

Longitudinal to diagonal cuts relative to the long axis of the axial skeleton were made through the cheek muscles from anterior (the side of the mouth opening) to posterior (the masseter muscle) with the knife held at a shallow angle with the bone surface. These cuts were made above the upper tooth row and were extended from the front to the back of the tooth row, severing the cheek muscles including the masseter. The knife point was then inserted in the vicinity of the coronoid process and mandibular condyle where a few cuts were made. The head was then turned and the same process was performed on the other side, except that the knife was used upside down for some cutting strokes. Again the knife point was inserted in the vicinity of the coronoid process and mandibular condyle where a few cuts were made. The knife was turned several times at this point, but cuts were predominantly made from front to back. The head was turned again and additional cuts were made with the knife inserted in the vicinity of the coronoid process and mandibular condyle.

Then the jaws were forced apart by one butcher holding the cranium - with the nose facing up - while a second butcher forced the lower jaw down or ventrally. After the mouth was stretched open to a certain extent, transverse cuts were made to sever connective tissues at the caudal end of the lower jaw. The jaws were then forced apart further till the mandible was dislodged from the cranium. Meat and connective tissues binding the mandible to the cranium were cut to separate the two elements. Cut marks produced by this activity are restricted to the area above the upper tooth row in the vicinity of the facial crest and tuberosity. Cut mark types include cuts and slices. Although three activities (skinning, filleting, and disarticulation) were performed on the cranium, the cut marks depicted in Figure 4.14 and presented in Table 4.2 (SFD) are the result of disarticulating the mandible from the skull. Although meat was cut during this process, it was done in the context of disarticulation and is therefore not strictly filleting.

### 4.3.1.2.4. Tongue removal

This activity is described below in section 4.3.2.2.3. No cut marks were produced on the cranium during this activity. This is most likely due to the fact that the mandible was usually
disarticulated from the skull before the tongue was removed. The latter was done at my request for purposes of establishing utility indices and does therefore not imply butchery sequence. If the tongue was removed prior to disarticulation of the mandible, one may expect that tongue removal cut marks could be produced on the palate by the point of the cutting tool. It is possible for marks to occur on the palate since the knife would be inserted from the ventral aspect of the cranium and subsequent longitudinal cutting strokes along the medial surfaces of the mandibles could impact the palate. Such marks would be longitudinal to diagonal with respect to the long axis of the axial skeleton.

4.3.1.2.5. Filleting

Strictly speaking, no filleting of the skull took place. However, disarticulating the mandible from the skull and removing the tongue required cutting through flesh and therefore cut marks associated with the latter activities may be termed filleting marks. Here I suggest that ‘filleting’ marks are in fact either associated with disarticulation of the mandible or removal of the tongue. The term filleting, therefore, does not strictly apply where it is included in figures and tables.
Table 4.2. Frequency distribution of cut marks on large bovid crania. D = disarticulation, S = skinning, SFD = skinning, filleting and disarticulation, SF = skinning and filleting, NM = nasal/maxilla, OC = occipital condyle, PA = parietal, FR = frontal, NL = nasal/lacrimal, NA = nasal, MA = maxilla, PM = premaxilla, MP = paramastoid process.

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4.3.2. MANDIBLE

4.3.2.1. Small Bovids

Four small bovid mandibles were retained after butchery observations were made. Figure 4.15 shows the distribution of cut marks produced by all butchery activities. Although four butchery activities were carried out, all cut marks except one are associated with skinning and/or filleting. The exception is a single shave/cut mark on the medial surface of the ventral border at the angle of the mandible. This mark may be the result of skinning, filleting, or tongue removal.

4.3.2.1.1. Skinning

The incision made to extract the lower and upper viscera was extended cranially in a straight line to the articulation between the left and right mandibles (mental symphysis). For more detail on evisceration incisions see section 4.2.1. The skin was worked loose from ventral to dorsal and from caudal to cranial by making diagonal to transverse cuts along the
ventral borders of the mandible with the knife held at an angle with the bone surface. Cutting actions were diagonal to transverse to the long axis of the mandible. Most of the time these cuts were made between skin and underlying soft tissues, but in some areas the bone is covered by very thin layers of soft tissue. The areas most likely to be impacted during skinning are where very thin layers of soft tissue cover the bone and the butcher finds it difficult to avoid tool to bone contact. On the mandible this includes the ventral border at the base of the ascending ramus or at the angle of the mandible, the ventral border below the tooth row, and the area surrounding the mental foramen (interalveolar border). Since there is little meat at these locations, the butcher sometimes impacted bone while freeing the skin. Where the mandible is covered by larger muscle masses the butcher managed to avoid contact with bone. Cut mark types produced during skinning are likely to include cuts, slices, shave/cuts, and shaves. Cut marks presented in Figure 4.15 are in locations where skinning is likely to produce cut marks on the mandible. Table 4.3 shows that skinning marks are most common on the body of the mandible on the buccal side, specifically along the ventral border as indicated in Figure 4.15.

4.3.2.1.2. Filleting

In my observations mandibles of small bovids were generally not filleted but either roasted over coals or boiled in a pot before removing the sinuous meat adhering to the mandible. Boiling was the preferred cooking method as it softened the meat. Meat was scraped, cut, or eaten directly from the bone. Consumers suggested that the small quantity of meat on a small bovid mandible does not warrant the time and energy required to remove it with a knife while still raw, and that the meat is softer and more readily removed after the mandible is boiled in water. Roasting tended to dry the meat, making it tough, less palatable and more difficult to remove from the bone. The locations where skinning marks occur coincide with those where muscle masses are severed and loosened during filleting as indicated in Figure 4.15. Table 4.3 shows that filleting marks are most common on the body of the mandible, particularly along the ventral border and the interalveolar border.

4.3.2.1.3. Tongue Removal

This procedure was always carried out before the mandible was disarticulated from the cranium so that the tongue was removed in one piece. The tongue was freed at its base with
diagonal to transverse cuts in the region of the hyoid bone. Unfortunately no hyoids were retained as these were removed along with the tongues for consumption. Transverse cuts on a buffalo hyoid were recorded by Bunn and Kroll (1986), which they argue are associated with hominid use of the tongue. My observations indicate that transverse cuts on the hyoid may result from tongue removal, but as I mention in section 4.3.2.2.3 disarticulation of the mandible from the cranium can not be ruled out. After the tongue was freed at its base it was loosened cranially by making longitudinal shaves along the medial surfaces of the mandible with the knife held at an acute angle with the bone surface. The knife was inserted between the mandible and the tongue from the ventral aspect. The shaving action was carried out along the medial or lingual surfaces to the vicinity of the mental symphysis. Figure 4.15(a) displays one cut that may be associated with either tongue removal, skinning, or filleting. The paucity of tongue removal cut marks on the lingual surfaces of small bovid mandibles supports the notion that small animals can be butchered by using fewer cutting strokes and applying more force and leverage. In my observations very few cutting strokes were used for removing the tongues of small bovids.

4.3.2.1.4. Disarticulating the mandible from the cranium

For small bovids this process can be completed without impacting the bone. A few cuts were made to sever the masseter muscle after which the jaw was forced ventrally to stretch and expose connective tissues. A few transverse to diagonal slices were made into connective tissues in the vicinity of the mandibular condyles, coronoid process, and mandibular notch, but force and leverage were dominant in disarticulating the mandible. As reflected in Figure 4.15 no cut marks were recorded where slicing actions were applied during disarticulation. Although disarticulation is included in the activity column of Table 4.3, no cut marks were produced by this activity.
Table 4.3. Frequency distribution of cut marks on small bovid mandibles. SF = skinning and filleting, SFD = skinning, filleting, and disarticulation, AM = angle of mandible, BM = body of mandible.

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4.3.2.2. Large Bovids

Butchery activities observed when processing mandibles include skinning, tongue removal, disarticulating the mandible from the skull, and filleting. Figure 4.16 shows cut marks produced by all butchery activities.

4.3.2.2.1. Skinning

Procedures were roughly the same as those described above in section 4.3.2.1.1. for small bovids except that the skin was worked loose from the caudal and dorsal surface for large bovids. Many more cutting strokes were applied and the task took considerably longer to complete for large bovids. Cutting motions were predominantly diagonal to longitudinal with respect to the long axis of the axial skeleton with the cutting edge held at an angle with the bone surface. Cut mark types produced by skinning include cuts, slices, shave/cuts, and shaves. Figures 4.17 and 4.18 display cut marks produced by either skinning, filleting, or disarticulation. After thorough examination of video footage it is clear that none of the marks in Figure 4.17 are associated with skinning, while most cut marks in Figure 4.18 were produced by skinning, specifically the cuts at the interalveolar border and along the edges of the ventral border. Cut marks on the body of the mandible above the angle of the mandible may have been produced by either severing the cheek muscles or during skinning. Severing
the cheek muscles was carried out while disarticulating the mandible from the skull. Therefore, ‘filleting’ in the caption of Figure 4.18 may be replaced by disarticulation. The point is that these cut marks were produced while severing flesh, but in the context of disarticulation. The same situation applies to filleting cut marks in Figure 4.19. In sum, unambiguous skinning marks are those located at the interalveolar border on the lateral surface of the mandible as well as cut marks along the ventral border of the body of the mandible. Table 4.4 shows that the vast majority of skinning cut marks are located on the body of the mandible with considerably fewer marks at the angle of the mandible and ascending ramus.

4.3.2.2.2. Disarticulating the mandible from the cranium

A more detailed description of this activity is given above in section 4.3.1.2.3, but here I focus on cutting actions not mentioned above which may impact the mandible. The longitudinal to diagonal cuts made just above the tooth row were extended back across the ascending ramus, coronoid process, and mandibular condyles while severing the cheek muscles including the masseter. These cuts were made with the edge of the cutting tool more or less perpendicular to the bone surface, but in some cases shaving actions were observed. These cuts were made through flesh and may thus be considered as filleting marks, but they were made in the context of disarticulation. When the knife was inserted in the vicinity of the coronoid process and mandibular condyle, several puncture marks were produced as can be seen in Figure 4.19. Cut mark types produced during disarticulation include cuts, slices, shave/cuts, shaves, and punctures. The distribution of cut marks produced by disarticulation is displayed in Figure 4.20. However, for reasons mentioned above, ‘filleting’ marks in Figures 4.17 and 4.19 were made in the context of disarticulation and are therefore attributed to the latter activity. The cut mark in Figure 4.17(a) may be the result of either skinning or disarticulation. In addition, the cut marks above the ventral border on the body of the mandible and the ascending ramus (Figure 4.18) are the result of filleting (in this context disarticulation) rather than skinning, since muscles in this region prevent tool to bone contact during skinning. Muscles at this location were severed when the mandible was disarticulated from the skull. Table 4.4 shows that the majority of disarticulation marks are located on the ascending ramus, followed by the coronoid process and body of the mandible. Very few cut marks were recorded on the mandibular condyle. Remember that, as described above, certain cut marks in categories FD, SF, and SFD of Table 4.4 are disarticulation cuts.
4.3.2.2.3. Tongue removal

The tongue was removed after disarticulating the mandible from the skull. The latter was done at my request to establish utility indices and does not imply butchery sequence. It is possible that the disarticulation process impacted the hyoid bones, but it is not possible to see the hyoids on video footage. The jaw was placed with the coronoid processes facing up and predominantly shaving motions were made with the knife held at a very shallow angle with the bone surface. These cuts were made against the lingual surfaces of the mandibles and were extended on both the left and right sides from the rear (in the vicinity of the angle of the mandible) to the mental symphysis. The mandible was then turned over with the ventral borders facing up and the same cuts were made from the ventral aspect. The cutting tool did not make contact with the ventral border of the mandible since the tool was used in a shaving fashion along the lingual surfaces. Cuts were extended from the vicinity of the angle of the mandible to the mental symphysis. In some cases cuts were made from cranial to caudal, but the reverse was more common. The mandible was turned again with the coronoid processes facing up and a few additional cuts were made at the mental symphysis to free the tongue. As expected from the above description, several shave/cuts and shaves were produced, but other cut mark types include cuts and slices. A few puncture/drag and one puncture were recorded. Cut marks produced by tongue removal are depicted in Figure 4.21. Table 4.4 shows that the vast majority of cut marks are located on the body of the mandible with very few marks at the angle of the mandible.

4.3.2.2.4. Filleting

Strictly speaking, no filleting of the mandible was observed except in removal of the tongue and severing of muscles while disarticulating the mandible. Although flesh was cut, the latter occurred during disarticulating the mandible from the skull. See the descriptions above in sections 4.3.2.2.1, 4.3.2.2.2, and 4.3.2.2.3.
Table 4.4. Frequency distribution of cut marks on large bovid mandibles. D = disarticulation, FD = filleting and disarticulation, RT = removal of the tongue, SF = skinning and filleting, SFD = skinning, filleting and disarticulation, AM = angle of mandible, BM = body of mandible, AR = ascending ramus, CP = coronoid process, MC = mandibular condyle.

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4.3.3. ATLAS

4.3.3.1. Small Bovids

Activities associated with butchering the atlas include disarticulation, evisceration, and filleting. Cut marks produced by all butchery activities are displayed in Figure 4.22.

4.3.3.1.1. Disarticulating the cranium from the atlas

Disarticulating the skull from the atlas is described above in section 4.3.1.1.2, but here I focus on the atlas. Transverse incisions were made to the ventral surface of the neck and to the vicinity of the articulation between the atlas and occipital condyles. The knife was mostly held perpendicular to the bone surface. Once the meat was cleaved, the head was levered back and forth to expose articular surfaces. A few transverse slices were made to the
articulation and connective tissues binding the skull to the atlas to separate the two. In some cases cutting strokes were applied to the dorsal surface of the articulation between the skull and the atlas. Figure 4.23 shows cut marks associated with disarticulation while Figure 4.24 presents cut marks related to either disarticulation or filleting. Table 4.5 shows that the majority of cut marks produced during disarticulation are on the cranial articular surface, followed by the atlas wing. Disarticulation marks occur on both the dorsal and ventral surfaces and consist predominantly of transverse incisions made perpendicular to the bone surface, but a few cut/shave and shave marks do occur, particularly on the cranial articular surfaces. A few nick/notch marks occur on the lateral borders of atlas wings.

4.3.3.1.2. Evisceration

In some cases the viscera were removed very carefully and in these instances the lower viscera were freed at their cranial extent after the head was severed from the neck. The trachea was loosened and a knot tied in it to prevent spoiling the meat with abdominal fluids during removal of the lower viscera. To free the trachea and associated tissues a few cuts were made on the ventral surface of the neck, longitudinal to the long axis of the axial skeleton with the knife held at an angle toward the vertebral centrum and/or ventral tubercle. When the upper viscera was removed, the esophagus and associated tissues were freed in the same manner as that described for the trachea. Since all cervical vertebrae underwent evisceration and filleting, cut marks resulting from evisceration can not be separated from those produced during filleting. From the video footage it is very difficult to see whether cuts made to remove the viscera actually reached the bone surfaces. However, if they did, these cuts are restricted to the ventral surfaces of the cervical vertebrae and will tend to be longitudinal, diagonal, to transverse with respect to the long axis of the axial skeleton. Cut mark types are expected to include cuts, slices, shave/cuts, and shaves. Some cut marks presented in Figure 4.25 as well as some filleting marks in Table 4.5 may be associated with evisceration.

4.3.3.1.3. Filleting

Due to their irregular morphology, cervical vertebrae (including the atlas) are difficult and time-consuming to deflesh thoroughly. Actions employed vary significantly and therefore I do not offer a detailed description of the manner in which these elements were
defleshed. Cut marks associated with defleshing the atlas are displayed in Figure 4.25. Butchery marks are longitudinal to diagonal to the long axis of the axial skeleton and include mostly cut and slice marks, but two shave marks are depicted in Figure 4.25. Almost all cut marks occur on the ventral surface with only one present on the dorsal surface. The ventral surface may retain more cut marks because both filleting and evisceration were performed on that surface whereas only filleting was performed on the dorsal surface. Beyond this observation I am unable to explain the near absence of cut marks on the dorsal surfaces. Table 4.5 shows that most filleting marks are on the atlas wings while a few occur on the cranial articular surface and the ventral tubercle. Cut marks associated with either filleting or disarticulation are depicted in Figure 4.24. The longitudinal cut mark (relative to the long axis of the axial skeleton) in Figure 4.24(b) is more likely the result of filleting since no longitudinal cutting motions were observed during disarticulation while such actions were common during filleting.

Table 4.5. Frequency distribution of cut marks on small bovid atlases. D = disarticulation, F = filleting, FD = filleting and disarticulation, AW = atlas wing, CA = cranial articular surface, VT = ventral tubercle.

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<tr>
<td>F (8)</td>
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<tr>
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<table>
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<tr>
<td>FD</td>
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</tr>
<tr>
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4.3.3.2. Large Bovids

Butchery activities observed during the processing of the atlas include disarticulating the skull from the atlas, evisceration, and filleting. Figure 4.26 displays cut marks produced by all butchery activities.

4.3.3.2.1. Disarticulating the cranium from the atlas

This procedure is described above in section 4.3.1.2.1. As expected from the above description, Figure 4.27 shows that cut marks produced by disarticulation cluster toward the cranial portion of the atlas. Cut marks on the dorsal and ventral surfaces are mostly transverse and consist predominantly of cuts and slices, though a few cut/shaves and shaves occur near and on the cranial articular surfaces. Cut marks on the cranial articular surfaces tend to be transverse, but increased variety in orientation was observed (Figure 4.27(c)). Cut mark types on cranial articular surfaces include slices, cuts, shave/cuts, shaves, punctures, and puncture/drag marks. Figure 4.28 displays cut marks produced by filleting and/or disarticulation. Certain marks may (with reasonable certainty) be attributed to either filleting or disarticulation for the following reasons. Disarticulation marks differ from filleting and evisceration marks in that the former are generally transverse to the long axis of the axial skeleton and made more or less perpendicular to the bone surface, particularly on non-articular surfaces. Although the butcher made cuts with the cutting tool perpendicular to joints during disarticulation, the articular surfaces were not always perpendicular to the cutting tool. Cut/shaves and shaves, therefore, were commonly produced on articular surfaces. Filleting and evisceration cutting motions were mostly longitudinal to diagonal relative to the long axis of the axial skeleton and the knife was generally held at an angle with the bone surface. Filleting and evisceration activities were never observed to impact the cranial articular surfaces of atlases. Conversely, the cutting edge was often in contact with articular surfaces during disarticulation. Table 4.6 indicates that disarticulation marks are most common on the cranial articular surface, but a considerable number of cuts occur on atlas wings.
4.3.3.2.2. Evisceration

The procedures employed were the same as those described above for small bovids in section 4.3.3.1.2, and for the same reasons given in that description, evisceration marks could not be isolated from filleting marks. Therefore, some marks attributed to filleting on ventral surfaces in the atlas figures and Table 4.6 may be the result of evisceration. The only difference in removing viscera from large and small bovids was that more cutting actions were required for large bovids. Evisceration activities recorded on video show that marks will be restricted to the ventral surfaces of the atlas and will tend to be longitudinal to diagonal relative to the long axis of the axial skeleton. No attributes were discovered to unambiguously distinguish filleting from evisceration cut marks. However, significantly fewer cutting strokes were applied during evisceration and therefore fewer marks are likely to result from evisceration compared with filleting.

4.3.3.2.3. Filleting

The same description as that given above for small bovids in section 4.3.3.1.3 applies to large bovids. However, a great deal more cutting was required to fillet large bovid cervical vertebrae and the task took considerably longer to complete in comparison with small bovids. A detailed description of the filleting process would be extremely lengthy and difficult since the knife was constantly turned and cutting actions were made from a variety of directions and angles. Cutting motions were predominantly diagonal to longitudinal with respect to the long axis of the axial skeleton, but some transverse cutting strokes were observed. Cut mark types include cuts, slices, shave/cuts, shaves, and punctures. Filleting cut marks are displayed in Figure 4.29. No filleting cut marks occur on the cranial articular surfaces. Figure 4.28 displays marks produced by either filleting or disarticulation.

As described above in section 4.3.3.2.1, certain marks can be attributed to single activities while others will remain ambiguous. Certain marks can be attributed to filleting because filleting actions were generally longitudinal to diagonal to the long axis of the axial skeleton and with the cutting edge held at a shallow angle with the bone surface. In contrast, disarticulation actions were always transverse to the long axis of the axial skeleton and with the cutting edge held more or less perpendicular to the bone surface. Where cut marks are transverse and their angulation can not be determined, they can not be attributed to a single butchery activity. When disarticulation cuts are on cranial articular surfaces they may have
angulation similar to filleting marks. However, filleting marks were not observed to occur on articular surfaces and therefore marks at that locality can safely be attributed to disarticulation. Table 4.6 indicates that the vast majority of filleting marks occur on the atlas wings with significantly fewer marks at the ventral and dorsal tubercles.

Table 4.6. Frequency distribution of cut marks on large bovid atlases. D = disarticulation, F = filleting, FD = filleting and disarticulation, AW = atlas wing, CA = cranial articular surface, VT = ventral tubercle, DT = dorsal tubercle.

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4.3.4. CERVICAL VERTEBRA

4.3.4.1. Small Bovids

Activities associated with processing the neck include evisceration, disarticulation, and filleting. Evisceration was completed before butchery commenced. Disarticulating the neck from the thoracic vertebrae enabled more than one butcher to fillet an animal. Cut marks produced by filleting and evisceration of axes are presented in Figure 4.30. These cuts are displayed separately from others on cervical vertebrae because filleting and evisceration were the only activities performed while processing axes. Additionally, axes are morphologically distinct from other cervical vertebrae. Table 4.7 includes cut marks produced on axes. Cut marks produced by all butchery activities on cervical vertebrae other than axes are presented in Figure 4.31.
4.3.4.1.1. Evisceration

This is described in more detail above in section 4.3.3.1.2. Since all cervical vertebrae underwent evisceration and filleting, cut marks resulting from evisceration can not be separated from those produced by filleting. Additionally, it is not clear from video footage whether evisceration cuts actually reached the bone surfaces. Evisceration cuts are restricted to the ventral surfaces of the cervical vertebrae and tend to be longitudinal, diagonal, to transverse with respect to the long axis of the vertebral column. Cut mark types are anticipated to include cuts, slices, shave/cuts, and shaves. Some marks depicted in Figures 4.30(d) and 4.33(a) as well as some filleting marks in Table 4.7 may result from evisceration.

4.3.4.1.2. Disarticulating cervical from thoracic vertebrae

The neck of one small bovid was severed from the thoracic vertebrae before filleting. The neck was held in the left hand. The butcher made a series of transverse cuts - with the knife held perpendicular to the bone surface – to the dorsal surface of the neck and towards the articulation between the last cervical vertebra and the first thoracic vertebra. Once the meat was cleaved, the neck was levered and snapped down or ventrally, exposing articular surfaces and connective tissues. A few more transverse cuts were applied, the neck snapped again, and then severed from the thoracic vertebrae by a few more cuts through connective tissues and flesh. In one instance the butcher cut between the sixth and seventh cervical vertebrae and therefore cut marks resulted on the cranial articular processes of the seventh cervical vertebrae. Cut marks are transverse to the long axis of the axial skeleton and consist mainly of cuts and slices though two shave/cuts and one puncture were recorded. Figure 4.32 displays cut marks associated with disarticulation. Table 4.7 shows that all disarticulation marks are located on the cranial articular processes.

4.3.4.1.3. Filleting

The outer muscles of the neck were removed quite readily with mostly longitudinal to diagonal cuts along the cervical vertebrae. However, the meat between adjacent vertebrae was more difficult to remove and the butcher’s actions varied considerably. Cutting actions were from several orientations and angles, producing a variety of cut marks. Cut marks are predominantly longitudinal to diagonal though some transverse marks were recorded on lateral, medial, and ventral surfaces of axes. Marks consist mostly of cuts and slices with
fewer punctures and shave/cuts. Figures 4.30 and 4.33 show cut marks associated with filleting. As mentioned above in section 4.3.4.1.1, some cuts on ventral surfaces may be the result of evisceration. Nevertheless, significantly fewer cutting strokes were applied during evisceration and therefore the majority of marks are more likely the result of filleting. Table 4.7 shows that filleting marks are present at several anatomical locations but are most common on transverse processes.

Table 4.7. Frequency distribution of cut marks on small bovid cervical vertebrae. F = filleting, D = disarticulation, CAP = caudal articular process, CE = centrum, CRP = cranial articular process, DP = dorsal spine, TP = transverse process, VA = vertebral arch, VS = ventral spine, VW = ventral wing, DW = dorsal wing, LCE = lower centrum.

<table>
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4.3.4.2. Large Bovids

Activities observed while processing the neck include evisceration, disarticulating cervical from thoracic vertebrae, and filleting. Although the values given for cervical vertebrae in Table 4.8 include cut marks on axes, Figure 4.34 shows the location of cut marks on axes separately. The latter was done because axes were never disarticulated from either atlases or cervical vertebrae and consequently only retain cut marks produced by filleting. Figures 4.35 and 4.36 show cut marks produced by all butchery activities.
4.3.4.2.1. Evisceration

This process is the same as that described above for small bovids in section 4.3.3.1.2. From video footage it is not possible to determine whether evisceration cuts impacted bone surfaces or not. Considerably fewer cutting strokes were applied during evisceration than during filleting. Distinguishing evisceration from filleting cut marks was not possible in this study, but it is expected that evisceration will leave significantly fewer marks than filleting. Nevertheless, video footage shows that evisceration actions are longitudinal to diagonal relative to the long axis of the axial skeleton and therefore cut marks are expected to be longitudinal to diagonal and restricted to the ventral surfaces of the cervical vertebrae. Some cut marks attributed to filleting in Figure 4.42(a) and Table 4.8 may be evisceration cuts. No attributes were found to distinguish between filleting and evisceration marks.

4.3.4.2.2. Disarticulating cervical from thoracic vertebrae

This activity was always carried out before the neck was filleted. Transverse cuts were made to the dorsal surface of the neck in the vicinity of the last cervical vertebra. These cuts were made through meat toward the articulation between the last cervical and first thoracic vertebra. After the meat was cleaved and the vertebrae exposed, a hand held electric saw was used in a few instances to cut through the vertebrae, severing the neck from the thorax. Sawing was executed from the dorsal surface, through the vertebrae, to the ventral surface. After the bones were sawn, the remainder of the flesh and connective tissues binding the bones were cut by knife to separate the neck from the thorax. Figure 4.37 shows the location of sawing marks and Table 4.8 shows the frequency distribution of saw marks.

When an electric saw was not used for disarticulating the neck from the thoracic vertebrae, the following method was employed. Transverse cuts relative to the long axis of the axial skeleton were made to the dorsal surface of the neck in the region of the last cervical vertebrae. On reaching bone, these cuts were extended to both the left and right sides of the neck, cleaving meat and exposing bone surfaces. The neck was then snapped down (ventrally) and twisted to one side, stretching, tearing, and exposing connective tissues. This procedure also exposed the articular surfaces of the vertebrae. Additional transverse cuts were made into connective tissues, articular processes, and articular surfaces after which the neck was snapped down and twisted sideways again. Finally the neck was severed from the thoracic vertebrae by cutting through meat and remaining connective tissues. Figures 4.38
and 4.39 show cut marks produced during disarticulation. The vast majority of these marks are transverse to the long axis of the axial skeleton and consist mostly of cut and slice marks. The latter reflect that during disarticulation the cutting tool was used more or less perpendicular to the joint and non-articular bone surfaces. Cut/shave and shave marks occur on the caudal articular surface of the vertebral centra (Figure 4.39(b)) because these surfaces are perpendicular to the joint and therefore parallel or in line with the cutting tool. In other words, once articular surfaces were exposed, cutting motions were made between adjacent vertebral centra with the cutting edge at a very shallow angle with the bone surfaces. Figures 4.40 and 4.41 display cut marks produced by filleting and/or disarticulation.

Disarticulation marks may be distinguished from filleting marks with reasonable certainty for the following reasons. Disarticulation cutting motions were strictly transverse to the long axis of the axial skeleton and the cutting edge was used more or less perpendicular to non-articular bone surfaces. Although some filleting actions may have been transverse to the long axis of the axial skeleton, the cutting edge was almost always at an angle with bone surfaces. It follows that the vast majority of transverse cut marks can be attributed to disarticulation except when marks were made at an angle with the bone surface. The latter may be the result of either disarticulation or filleting. Filleting actions are most commonly longitudinal to diagonal to the long axis of the axial skeleton. In this study, disarticulation actions were not observed to impact the ventral surfaces, transverse processes, or dorsal spines of cervical vertebrae. Table 4.8 shows that most disarticulation marks occur on centra and cranial articular processes, followed by the upper centra and caudal articular processes. Considerably fewer marks are present on rib facets, ventral and dorsal wings, and the lower centra.

4.3.4.2.3. Filleting

The same descriptions given above in sections 4.3.3.1.3, 4.3.3.2.3, and 4.3.4.1.3 apply here. However, a great deal more cutting was required to deflesh large bovid necks and considerably more time was required to complete the task than with small bovids. A full description of this procedure will be very lengthy and difficult because the butcher constantly turned the knife and cut from a variety of angles and directions. Nevertheless, most filleting actions were diagonal to longitudinal in relation to the long axis of the axial skeleton with the cutting edge held at a shallow angle with the bone surface. As mentioned above section
4.3.4.2.1, certain cut marks on the ventral surfaces of cervical vertebrae may result from evisceration. However, since few cutting strokes were employed during evisceration, the vast majority of cut marks at this locality are more likely the result of filleting. Cut mark types produced by filleting include cuts, slices, shave/cuts, shaves, and a few punctures. Filleting marks are presented in Figures 4.30 and 4.42. Cut marks produced by either filleting or disarticulation are displayed in Figure 4.40. Certain cut marks in this figure may be attributed to single activities for the following reasons. Filleting cut marks are commonly diagonal to longitudinal and made at an angle to the bone surface, while disarticulation marks are exclusively transverse to the long axis of the axial skeleton and made with the cutting edge more or less perpendicular to non-articular bone surfaces. Where cut marks are transverse and their angulation cannot be determined, they can not be assigned to a single activity. Table 4.8 shows that filleting marks occur on most anatomical locations, except for rib facets, but are most numerous at the transverse processes, centra, dorsal spines, and ventral wings.

Table 4.8. Frequency distribution of cut marks on large bovid cervical vertebrae. F = filleting, FD = filleting and disarticulation, D = disarticulation, SAF = sawing and filleting, CAP = caudal articular process, CE = centrum, CRP = cranial articular process, DP = dorsal spine, TP = transverse process, VA = vertebral arch, VS = ventral spine, WB = whole bone, VW = ventral wing, DW = dorsal wing, UCE = upper centrum, LCE = lower centrum, RF = rib facet.

(a) Portion

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4.3.5. THORACIC VERTEBRA

4.3.5.1. Small Bovids

Activities observed during the butchery of thoracic vertebrae include evisceration, filleting, disarticulating the ribs, and disarticulating thoracic from lumbar vertebrae. Figures 4.43, 4.44, and 4.45 show cut marks produced by all butchery activities. Figures presenting cut marks on thoracic vertebrae include only those elements that retained evisceration marks. This decision was taken because butchery activities associated with thoracic vertebrae were repetitive and because digitizing all cut marks on all thoracic vertebrae would have been too time-consuming. Thoracic vertebrae with evisceration marks were selected because this activity may be an indicator of early access to animal carcasses. I am confident that the distribution of cut marks displayed in the figures are representative of the overall patterning of cut marks on thoracic vertebrae. Table 4.9 includes all cut marks on all thoracic vertebrae for which butchery observations were made.

4.3.5.1.1. Evisceration

The centra and ventral surfaces of thoracic vertebrae are associated with the upper viscera. A more detailed description of the initial stages of evisceration is given above in section 4.2.1. In some cases, before any cuts were made to free the upper viscera from the abdominal cavity, the rib cage was split at the sternum and opened to facilitate evisceration. This process is described in more detail above in section 4.2.1. Before loosening the upper viscera from the abdominal cavity, the knife was used to cut through the diaphragm. Then organs of the upper viscera were loosened by making transverse to diagonal cuts relative to the long axis of rib shafts from cranial to caudal - along the medial surfaces of the ribs – commonly near the distal end, mid and proximal shaft, but normally below the angle of ribs. Transverse, diagonal, to longitudinal slices to free the upper viscera were also made in the vicinity of the ventral surfaces of the thoracic vertebral centra. After the upper viscera were loosened from the cervical vertebra they were pulled free from the abdominal cavity in one piece. Cut marks associated with evisceration are depicted in Figures 4.46 and 4.47. Cut marks that may be associated with either evisceration, filleting, or disarticulating ribs are presented in Figures 4.48 and 4.49. However, since there is significant overlap in the locations of marks resulting from different activities as depicted in Figures 4.48, 4.49, and figures displaying filleting marks, cut marks at these locations can not be attributed to a
single activity. Table 4.9 shows that evisceration cut marks are most common on the lower (inferior) centrum, with fewer marks on the middle portion of centra and transverse processes.

4.3.5.1.2. Filleting

Muscles associated with thoracic vertebrae are on the dorsal surfaces adjacent to the dorsal spines and extend from the sacrum to the last few cervical vertebrae. Removing these muscles is described in detail below in section 4.3.6.1.3. Filleting marks consist almost entirely of cut and slice marks. The location of cut marks associated with filleting are presented in Figures 4.50 and 4.51 while marks resulting from either filleting, evisceration, or disarticulating ribs are presented in Figures 4.48, 4.52, and 4.53. Table 4.9 shows that most filleting cut marks occur on dorsal spines, followed by transverse processes. Fewer marks occur on vertebral arches, cranial articular processes, caudal articular processes, and upper centra.

4.3.5.1.3. Disarticulating ribs from thoracic vertebrae

This butchery activity was not normally carried out when carcasses were defleshed for drying meat and for making sausage. It is not necessary to disarticulate ribs from thoracic vertebrae in order to deflesh them. Disarticulating the ribs is a time-consuming process and does not facilitate filleting. Disarticulating ribs is common among modern hunter-gatherers (e.g., Bartram 1993a; Binford 1978, 1981; O’Connell et al. 1990; Yellen 1977b), probably because ribs are sometimes consumed at the butchery or kill site and because disarticulation makes rib slabs easier to transport. I requested this activity to be carried out to gain an understanding of the process involved in separating ribs from the vertebral column. Only one small bovid was processed in this fashion.

All cutting actions were made to the medial surfaces of proximal ribs, above the angle of ribs. Since viscera were not present, the joints between ribs and vertebrae were clearly visible and the butcher could cut directly to the joints. The knife was inserted at the junction between the proximal epiphysis of the last rib and the last thoracic vertebrae, where the rib head and tubercle articulate with the rib facets of the thoracic vertebrae. The knife was held in a stabbing grasp and pulled toward the front of the animal. These actions either cut the rib heads off entirely or removed part of the rib facets. Where this action could not be employed,
the knife point was inserted between the rib head and tubercle and the rib facets and levered back and forth to sever connective tissues. Most actions were longitudinal to the long axis of the axial skeleton. After connective tissues were severed, the rib cage was snapped dorsally to expose the articular surfaces and remaining connective tissues. The latter were cut and the ribs freed from the thorax. Figure 4.54 shows cut marks produced by disarticulating the rib cage. Cut marks displayed in Figures 4.49, 4.52, and 4.53 were produced by either disarticulation of ribs, evisceration, or filleting. Marks at locations where different butchery activities overlap can not be attributed to a single activity. Cut marks, which are unambiguously attributed to disarticulating ribs, are those on rib facets as shown in Figure 4.54(b). Table 4.9 indicates that the majority of disarticulation marks occur on the transverse processes followed by the rib facets. Very few cut marks are located on the vertebral centra.

4.3.5.1.4. Disarticulating thoracic from lumbar vertebrae

Only one animal was processed in this way for purposes of establishing utility indices and to gain an understanding of the actions involved in separating thoracic from lumbar vertebrae. Under normal conditions this activity was never carried out. Disarticulation occurred after filleting. Working toward the ventral surface of the vertebral column, the butcher first located the joint by hand. Transverse cuts were then made directly to the centra of the last thoracic and first lumbar vertebrae. After very few cuts the vertebral column was snapped dorsally (away from where the cuts were made), exposing connective tissues. The latter were cut to free the thoracic from the lumbar vertebrae. This activity took in the region of five seconds and no cut marks were produced.
Table 4.9. Frequency distribution of cut marks on small bovid thoracic vertebrae. F = filleting, EF = evisceration and filleting, E = evisceration, EDR = evisceration and disarticulating ribs, FDR = filleting and disarticulating ribs, DR = disarticulating ribs, CAP = caudal articular process, CE = centrum, CRP = cranial articular process, DP = dorsal spine, TP = transverse process, VA = vertebral arch, UCE = upper centrum, LCE = lower centrum, RF = rib facet.

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4.3.5.2. Large Bovids

Butchery activities observed while processing thoracic vertebrae include evisceration, disarticulating thoracic from cervical vertebrae, filleting (removal of the sirloins), disarticulating the ribs, and disarticulating thoracic from lumbar vertebrae. Activities normally carried out when processing animals for drying meat and for making sausage include evisceration, disarticulating the neck from the thoracic vertebrae, and filleting. Evisceration, disarticulating the neck from the thoracic vertebrae, and filleting are described in the order they were carried out, but the order of other activities does not imply sequence of butchery. Cut marks produced by all butchery activities are presented in Figures 4.55, 4.56, 4.57, and 4.58.
4.3.5.2.1. Evisceration

Upper viscera are associated with the centra of thoracic vertebrae. No meat is associated with the ventral surfaces of thoracic vertebrae except in the region of the transverse processes where intercostal meat adheres to thoracic vertebrae. The procedure of evisceration was the same as that described above for small bovids in section 4.3.5.1.1 except that more cutting strokes were applied for large bovids. The diaphragm was cut with longitudinal to diagonal cuts relative to the long axis of the axial skeleton toward the medial surfaces of ribs. After the trachea and esophagus were freed from the cervical vertebrae, the upper viscera were lifted from the abdominal cavity. To free the upper viscera completely, a few more longitudinal, diagonal, to transverse cuts were made toward the ventral surfaces of vertebrae.

Figures 4.59 and 4.60 display cut marks produced by evisceration. Marks are most commonly diagonal - followed by longitudinal and transverse - to the long axis of the axial skeleton and include numerous shave/cut and shave marks. Cuts and slices are also present. Table 4.10 indicates that the majority of evisceration cut marks are located on the lower centra with notably fewer marks on the upper (superior) centra, middle portion of centra, transverse processes, and caudal articular processes. Cut marks produced by other activities such as filleting, disarticulation, and disarticulating ribs may overlap with evisceration marks. In the case of marks produced by evisceration and/or filleting (Figures 4.61 and 4.62), cut marks are located on the upper centra and transverse processes. These marks are most commonly transverse to the long axis of the axial skeleton and were produced when the butchery tool was run toward the vertebrae along the anterior or posterior margin of the rib during removal of intercostal meat. Because cut marks on transverse processes and upper vertebral centra may be produced by either evisceration or filleting, cuts at these locations are ambiguous and can not be attributed to a single activity. Table 4.10 shows that marks produced by evisceration and/or filleting are only located at transverse processes and upper centra. Marks produced by evisceration and/or filleting and/or disarticulation (Figure 4.62) are located on transverse processes. This supports the notion that marks at this location can not be attributed to a single activity. Table 4.10 shows that very few marks were attributed to evisceration, filleting, and disarticulation (EFD) and that all are located on transverse processes. Figures 4.63 and 4.64 display cut marks produced by evisceration and/or disarticulating ribs.

Unlike ambiguous marks described above, evisceration marks may be distinguished from marks produced by disarticulating ribs with reasonable certainty. Because evisceration was
always completed before disarticulating ribs from thoracic vertebrae, the articulation between
the rib head and tubercle and the rib facets of the thoracic vertebrae were clearly visible to the
butcher and he made his cuts directly to joints. The locations of overlap between these
activities are the centra, upper centra, and rib facets. As described in section 4.4.11.1.4,
cutting actions applied when disarticulating the ribs were longitudinal to the long axis of the
axial skeleton and therefore certain cut marks at the centra can be attributed to either
evisceration or disarticulating ribs. Evisceration marks may be longitudinal, diagonal, or
transverse, whereas marks produced by disarticulating ribs are overwhelmingly longitudinal.
Additionally, disarticulation cuts were made directly toward the joints whereas evisceration
cuts were not aimed at joints.

In sum, unambiguous evisceration marks are located on the inferior aspect of centra and
on the centra, but at the latter location they are usually not longitudinal to the long axis of the
axial skeleton and not made directly toward the articulation between the proximal ribs and
thoracic vertebrae. Marks on the lower centra are almost always diagonal with fewer
longitudinal marks. Very few transverse marks were observed on lower centra. Where
transverse marks occur on the edges of the cranial or caudal articular surfaces of the vertebral
centra, they were more than likely produced by disarticulation.

4.3.5.2.2. Disarticulating cervical from thoracic vertebrae

This procedure is described above in section 4.3.4.2.2. Cutting motions were transverse
to the long axis of the axial skeleton and made toward the cranial half of thoracic vertebrae.
With the exception of the two transverse cut marks displayed in Figure 4.67(a), which are
undoubtedly the result of disarticulation, the locations of cut marks in Figures 4.65, 4.67,
4.68, and 4.69 overlap with locations of marks produced during disarticulating ribs. Therefore
marks at these locations are ambiguous and can not be attributed to a single activity.
Similarly, values given for disarticulation in Table 4.10 do not imply that marks at given
anatomical locations are strictly associated with disarticulation. Due to this ambiguity, the
only marks unequivocally associated with disarticulation are the two transverse cuts
displayed in Figure 4.67(a).
4.3.5.2.3. Filleting

Removing the sirloins from the thoracic vertebra and proximal lateral surfaces of ribs was carried out in the same manner as described below for small bovids in section 4.3.6.1.3. However, an additional method was observed when processing large bovids. In this scenario ribs were disarticulated from thoracic vertebrae before the sirloins were removed. During the last stage of disarticulating the ribs, the butcher freed the sirloins from the ribs by making longitudinal to diagonal cuts relative to the long axis of the axial skeleton between the proximal lateral surfaces of ribs and the ventral surface of the sirloin. After the ribs were detached, the butcher made longitudinal cuts between the dorsal surfaces of the transverse processes of thoracic vertebrae and the ventral part of the sirloin. The muscles were then rolled away from the base towards the apex of the dorsal spines. It seemed that the muscles were removed very easily and the butcher was mostly cutting connective tissues as opposed to cutting against bone. During this process a second butcher held the axial skeleton while the butcher made his cuts. The sirloin was worked free from caudal to cranial. It appeared that this method was as effective as that referred to above and that possibly fewer cut marks were produced on the dorsal spines. The latter will need to be evaluated in future research.

Additional meat associated with thoracic vertebrae is the extension of intercostal meat that adheres to thoracic vertebrae in the vicinity of the transverse processes. Cut marks are overwhelmingly longitudinal and diagonal to the long axis of the axial skeleton and include cuts, slices, shave/cuts, and shaves. Cut marks produced by filleting are displayed in Figures 4.70, 4.71, 4.72, and 4.73. Cut marks that are unambiguously attributed to filleting are those on the dorsal spines, dorsal surfaces of the cranial and caudal articular processes, and the dorsal surfaces of transverse processes. Cut marks on the lateral, ventral, and caudal surfaces of transverse processes, on upper centra, rib facets, and caudal surfaces of articular processes are produced during filleting and disarticulation of ribs and can therefore not be attributed to a single activity. Cut marks produced by a combination of filleting, disarticulation, and disarticulating ribs are presented in Figures 4.74, 4.75, and 4.76. The two lower cut marks in Figure 4.76(c) are more likely the result of filleting. Table 4.10 shows that most filleting marks occur on dorsal spines with considerably fewer cuts on transverse processes. Fewer cuts are located on vertebral arches and cranial articular processes and very few cuts were observed on upper centra, caudal articular processes, and rib facets.
4.3.5.2.4. Disarticulating ribs from thoracic vertebrae

This procedure is described below in section 4.4.11.1.4. Figures 4.77, 4.78, 4.79, and 4.80 display cut marks produced during this activity. Due to time constraints and because the placement of cut marks were very repetitive, only thoracic vertebrae with evisceration marks were used to generate the figures presented here. However, Table 4.10 includes cut marks on all vertebrae for which butchery observations were made. The ambiguity of marks at the centra, upper centra, and the cranial and caudal surfaces of transverse processes is described above. At these locations marks can not be attributed to a single activity. The vast majority of marks resulting from disarticulating ribs are longitudinal to diagonal to the long axis of the axial skeleton and include cuts, slices, shave/cuts, shaves, punctures, and puncture/drags. Cuts were made directly to joints, particularly rib facets. The cranial and caudal views of the figures listed above show that cuts were commonly made into rib facets, in some cases shearing them off entirely. Table 4.10 shows that most marks produced by this activity occur on rib facets. A considerable number of marks occur on transverse processes and somewhat less on upper centra and centra. Very few cuts are present on cranial articular processes, vertebral arches, caudal articular processes, dorsal spines, and lower centra.

4.3.5.2.5. Disarticulating thoracic from lumbar vertebrae

As stated previously, this activity was not normally conducted when processing animals for drying meat and to make sausage. This activity was performed after the sirloins and tenderloins were removed, and therefore the butcher could see the joints and made cuts directly to them. In a few instances a hand held electric saw was used for this activity, but on all occasions the saw impacted the lumbar rather than thoracic vertebrae. Transverse cuts relative to the long axis of the axial skeleton were made to the ventral surfaces of vertebrae into intervertebral fibro-cartilages. Fibro-cartilages prevented the cutting tool from making contact with bone. After several transverse strokes were applied the vertebrae were snapped dorsally, stretching and tearing connective tissues and exposing articular surfaces. Further transverse cuts were made in the vicinity of the upper centra and ventral surfaces of caudal articular processes. Again the vertebrae were snapped dorsally after which a few cuts were made through connective tissues to separate the thoracic from lumbar vertebrae. Cut marks produced by disarticulation are displayed in Figure 4.66. Cut marks at the upper centra (Figure 4.66(a) and (b)) overlap with marks produced by filleting and disarticulating ribs.
Therefore, the only marks unambiguously associated with disarticulation are those on caudal articular surfaces. These cuts are transverse to the long axis of the axial skeleton and were made perpendicular to the bone surface. Dashed lines in Figure 4.66(c) represent marks on the ventral surfaces of the caudal articular processes. For reasons given above, the values for disarticulation in Table 4.10 do not imply that marks at these locations are strictly associated with disarticulation.
Table 4.10. Frequency distribution of cut marks on large bovid thoracic vertebrae. F = filleting, FD = filleting and disarticulation, D = disarticulation, EF = evisceration and filleting, E = evisceration, EDR = evisceration and disarticulating ribs, FDR = filleting and disarticulating ribs, DR = disarticulating ribs, EFD = evisceration, filleting and disarticulation, DDR = disarticulation and disarticulating ribs, CAP = caudal articular process, CE = centrum, CRP = cranial articular process, DP = dorsal spine, TP = transverse process, VA = vertebral arch, UCE = upper centrum, LCE = lower centrum, RF = rib facet.

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4.3.6. LUMBAR VERTEBRA

4.3.6.1. Small Bovids

For the same reasons given above in section 4.3.5.1, only elements with evisceration marks were included in the production of figures presented here. Table 4.11 includes cut marks on all lumbar vertebrae for which observations were made. Butchery activities associated with lumbar vertebrae include evisceration, removal of the tenderloins (fillets), removal of the sirloins, disarticulating lumbar from thoracic vertebrae, and disarticulating the lumbar vertebrae from the sacrum. The latter two activities were not normally carried out. Figure 4.81 displays cut marks produced by all butchery activities.

4.3.6.1.1. Evisceration

Ventral surfaces of lumbar vertebrae are associated with the lower viscera. The lower viscera were removed mostly by hand although a few cuts were applied to free them from the abdominal cavity. After most of the lower viscera were extracted by hand, a few diagonal to transverse cuts were made in the vicinity of the lower vertebral centra of the lumbar vertebrae. The knife was mostly held at an angle with the bone surface although a few perpendicular motions were observed. Figure 4.82 displays cut marks produced during evisceration while Figures 4.83 and 4.84 show cut marks that were produced by either evisceration, filleting, or disarticulation. Due to overlap in the location of butchery actions, cut marks in the latter two figures can not be attributed to a single activity. Table 4.11 shows that very few evisceration cut marks were produced and are restricted to the centrum, upper centrum, and lower centrum.

4.3.6.1.2. Removing the tenderloins or fillets

Muscles comprising the tenderloins or fillets include the psoas minor and psoas major. Working from the ventral surface of the animal, the knife was inserted at the sacrum, appearing to impact the ventral surfaces of the sacrum wings. The knife blade was nearly perpendicular to the axial skeleton but not necessarily to the bone surface and cuts were made longitudinally to diagonally - with respect to the long axis of the axial skeleton - from the wings of the sacrum to the transverse processes of the lumbar vertebrae adjacent to the centrum. The latter was exposed during evisceration and was therefore easily avoided by the
butcher. He always tried to avoid unnecessary and prolonged contact with bone. The butcher worked from the rear to the front of the animal. In butchering small bovids, the fillets were removed very easily with only a few incisions made, after which the meat was pulled free by hand. After the cranial end of the muscle was pulled free it was severed by a few cuts where it connects with the medial proximal surface of the rear limb. Figure 4.85(d) displays the location of cut marks associated with removing tenderloins. Cut marks that were produced by either filleting, evisceration, or disarticulation are displayed in Figures 4.83 and 4.84. For reasons mentioned above cut marks in the latter figures can not be attributed to a single activity. Cut marks associated with the removal of tenderloins are located on only the ventral surfaces of lumbar vertebrae, particularly on transverse processes. The filleting category in Table 4.11 includes data for both tenderloin and sirloin removal. Values indicate that most marks are located on transverse processes.

4.3.6.1.3. Removing the sirloins

The sirloins include the longissimus dorsi muscles, which are situated along both sides of the dorsal spines and dorsal surfaces of transverse processes of lumbar and thoracic vertebrae as well as the lateral proximal surfaces of rib shafts. First a transverse cut was made at the base of the back, with the knife held perpendicular to the bone surface. This cut was made down to the vicinity of the articulation between the sacrum and lumbar vertebrae. This incision separated the loin muscles from the small flat muscles at the base of the back. Then two extensive longitudinal cutting actions were applied to both sides of the dorsal spines spanning from the lumbar vertebrae to the base of the neck (last few cervical vertebrae).

Sinuous membranes encasing the loin muscles were removed before the muscles were freed from the carcass. After the muscles were freed at their attachment with the dorsal spines, the knife was inserted from the lateral or medial (depending on the side being filleted and possibly on the handedness of the butcher) side of the muscles. The blade was used diagonal to transverse to the long axis of the axial skeleton and at an acute angle with the bone surface, working the muscles loose from the rear to the front – holding the rear end of the muscle with one hand while cutting it free with the other. These cuts impacted the transverse processes of lumbar vertebrae as well as parts of thoracic vertebrae and ribs. The latter is described in section 4.4.11.1.3. The weight of the muscles as well as leverage were used to free them. The last portion of the muscles was pulled free from the vertebral column.
where they end in the vicinity of the last few cervical vertebrae. Figure 4.85(a), (b), and (c) shows the location of cut marks associated with removing the sirloins. These cuts are all located on the dorsal surfaces of the lumbar vertebrae. The filleting category in Table 4.11 includes data for both tenderloin and sirloin removal, and the values indicate that most marks are located on transverse processes and dorsal spines with fewer cut marks on cranial articular processes and vertebral arches.

4.3.6.1.4. Disarticulating lumbar from thoracic vertebrae

This activity is described above in section 4.3.5.1.4. No cut marks were produced by this activity.

4.3.6.1.5. Disarticulating lumbar vertebrae from the sacrum

A few transverse cuts were made to the ventral surface of the bones between the caudal articular surface of the centrum of the last lumbar vertebra and the cranial articular surface of the centrum of the sacrum. The bones were snapped dorsally, loosening and exposing connective tissues. The latter were cut to free the lumbar vertebrae from the sacrum. It is possible that cut marks in Figure 4.84(d) resulted from this activity, but because of reasons described above these marks can not be attributed to a single activity with any certainty.
Table 4.11. Frequency distribution of cut marks on small bovid lumbar vertebrae. F = filleting, EF = evisceration and filleting, E = evisceration, EFD = evisceration, filleting and disarticulation, CAP = caudal articular process, CE = centrum, CRP = cranial articular process, DP = dorsal spine, TP = transverse process, VA = vertebral arch, UCE = upper centrum, LCE = lower centrum.

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4.3.6.2. Large Bovids

Activities observed while butchering lumbar vertebrae include evisceration, removal of the tenderloins, removal of the sirloins, disarticulating lumbar vertebrae from the sacrum, and disarticulating lumbar from thoracic vertebrae. Sirloin and tenderloin removal may occur in any order. Figures 4.86 and 4.87 display cut marks produced by all butchery activities.

4.3.6.2.1. Evisceration

The lower viscera are associated with lumbar vertebrae. The skin and abdominal wall was pieced just caudal of the last sternebra with a short longitudinal incision along the mid-line of the animal on the ventral surface. It appears that the skin was pierced at this point as the skin is taut here. The butcher inserted his hand upside down into the incision and guided the knife between his index and middle fingers. While the skin was raised with the left hand, the knife was inserted upside down and a series of short ‘pulling’ cuts were made away from
the butcher toward the crotch. In other words, from the last sternebra to the pubic symphysis. The skin was lifted and the knife used upside down to avoid piercing the stomach and other internal organs. This prevented abdominal fluids from contaminating surrounding meat. The lower viscera were then pulled from the abdominal cavity, but before they could be removed entirely the butcher used the knife to free the lower viscera. A few cuts were made in the vicinity of the ventral surfaces of the lumbar vertebrae.

Since the tenderloins were still in place, the only areas that could be impacted by these cuts are the lower centra of the vertebrae. It is very difficult to see the orientation and number of cuts made inside the abdominal cavity since the abdominal wall obscured the butcher’s hand. Cut marks are longitudinal, diagonal, to transverse relative to the long axis of the axial skeleton and consist of cuts, slices, shave/cuts, and shaves. Since evisceration was always completed before filleting, surfaces covered by meat were not likely impacted during evisceration. These surfaces include the centra, upper centra, and transverse processes. Hence, the only surfaces subjected to evisceration cuts were the lower centra. By the same token, since the lower centra were clearly visible to the butcher after evisceration, he could make his filleting cuts directly to the centra, upper centra, and transverse processes. Cut marks produced by evisceration are displayed in Figure 4.88. Figures 4.89 and 4.90 display cut marks produced by either evisceration, filleting, or disarticulation. As mentioned above, the lower centrum is the only location unambiguously associated with evisceration. Therefore cuts on the centra, upper centra, and transverse processes are more likely the result of filleting. Table 4.12 shows that nearly all evisceration marks are located on the lower centra, with only one mark located on the centrum.

4.3.6.2.2. Removing the tenderloins or fillets

This procedure was the same as that described above in section 4.3.6.1.2 for small bovids except that more cuts and time were required to complete the task. Longitudinal cuts relative to the long axis of the axial skeleton were made from the sacrum wings along the centra, upper centra, and medial parts of the ventral surfaces of the lumbar transverse processes. The tenderloins were then pulled away from the vertebral centra and additional longitudinal cuts were made along the ventral surfaces of transverse processes with the cutting edge angled away from the vertebral column. These cuts were applied more or less across the width of transverse processes. After the tenderloins were freed from the lumbar vertebrae they were
pulled up by their anterior end and severed caudally with a few diagonal to transverse cuts in the vicinity of the proximal medial surface of the hind limb. Cut marks are predominantly longitudinal to diagonal with some transverse cuts present. Cut mark types include cuts, slices, shave/cuts, and shaves. Cut marks associated with the removal of the tenderloins are depicted in Figures 4.89 and 4.91(a), (b), and (d). In Figure 91(a) and (b) only cut marks on the vertebral centra are associated with the removal of the tenderloins. Cut marks produced by either filleting, evisceration, or disarticulation are depicted in Figures 4.90(a) and (d), and 4.92(d). These cut marks can not be attributed to a single activity. Marks produced by both tenderloin and sirloin removal are lumped as filleting marks in Table 4.12. Nevertheless, this table shows that the vast majority of cut marks produced by tenderloin removal are located on the transverse processes with a few cuts on upper centra.

4.3.6.2.3. Removing the sirloins

Procedures employed were the same as those described for small bovids in section 4.3.6.1.3 except that more cutting strokes were applied for large bovids. An alternative method, as described in section 4.3.5.2.3, was observed. Here the sirloin was worked loose by making longitudinal cuts relative to the long axis of the axial skeleton from the lateral portions of transverse processes towards the dorsal spine with the knife held at an angle with the bone surface. After the muscles were freed from the transverse processes, they were rolled away from the latter and longitudinal to diagonal cuts were made between the dorsal spines and the sirloin, cutting from the base toward the apex of dorsal spines. Muscles were worked loose from caudal to cranial. Cut marks on both transverse processes and dorsal spines are mostly longitudinal to diagonal with a few cuts transverse to the long axis of the axial skeleton. Cut marks include cuts, slices, shave/cuts, shaves, punctures, and puncture/drag. Figure 4.91(a), (b), and (c) displays cut marks produced by removing the sirloins. In (a) and (b) the vertebral centra are not affected. Cut marks produced by either filleting or disarticulation are shown in Figures 4.90(c) and 4.92(c). Table 4.12 indicates that most filleting marks are located on transverse processes and dorsal spines with fewer marks on cranial articular processes and vertebral arches. Even fewer marks are located on caudal articular processes.
4.3.6.2.4. Disarticulating lumbar from thoracic vertebrae

A description of this activity is given above in section 4.3.5.2.5. Cutting motions were always transverse to the long axis of the axial skeleton. Transverse cuts were made to the ventral surface between the articular surfaces of the last thoracic vertebra and first lumbar vertebra. The knife point was sometimes inserted between the articular surfaces and levered back and forth to sever connective tissues. The thoracic vertebrae were snapped ventrally, tearing, stretching, and exposing connective tissues between the first lumbar and last thoracic vertebrae. Additional transverse cuts were made to expose connective tissues and meat to sever lumbar from thoracic vertebrae. Cut marks produced by disarticulation are displayed in Figure 4.94. Marks produced by either filleting or disarticulation are shown in Figures 4.90(c) and (d), and 4.92. I am unable to determine whether cuts in the latter two figures were made by either filleting or disarticulation. Table 4.12 shows that the majority of disarticulation marks are located on the cranial articular processes. Bear in mind that disarticulation cuts at the caudal articular process are associated with disarticulating the lumbar vertebrae from the sacrum.

4.3.6.2.5. Disarticulating lumbar vertebrae from the sacrum

Transverse cuts relative to the long axis of the axial skeleton were made on the ventral surface directly between the vertebral centra of the last lumbar vertebra and the sacrum. The cutting edge was held perpendicular to the axial skeleton but not necessarily to the articular surfaces of the vertebral centra. Then the knife point was inserted between the centra and levered back and forth perpendicular to the long axis of the vertebral column, severing connective tissues. The unit was turned over and transverse cuts relative to the long axis of the axial skeleton were made to the dorsal surface between the last lumbar vertebra and the sacrum. These cuts were made toward the joints between the vertebral centra. These transverse cuts were then extended to both the left and right sides of the vertebral column where they were directed toward the caudal articular processes of the last lumbar vertebra and the cranial articular processes of the sacrum. The sacrum was then snapped downwards or ventrally, after which connective tissues were severed with transverse cuts. The sacrum was snapped down again, tearing and stretching connective tissues that were cut to free the sacrum from the lumbar vertebrae. Cut mark types produced by these activities consist mostly of cuts and slices. Disarticulation cut marks are shown in Figures 4.94 and 4.95. Note that the
marks on the caudal portion of the lumbar vertebra are attributed to disarticulating the latter from the sacrum. Table 4.12 shows that the majority of these marks are located at the caudal articular process. Very few marks were recorded at other anatomical locations. The paucity of cut marks on vertebral centra and their articular surfaces is because these surfaces are covered by intervertebral fibro-cartilages which protect the bone surface from the cutting edge.

4.3.6.2.6. Sawing

In three cases the lumbar vertebrae were sawn from the sacrum. This was done after the tenderloins and sirloins were loosened cranially to prevent sawing them into two pieces. The saw was inserted at the articulation between the lumbar vertebrae and the sacrum from the right side. The bones were then sawed through from the right side to the left. Figure 4.93 shows saw marks and Table 4.12 indicates that sawing marks were more often made through the whole bone. One saw mark is located at both the caudal articular process and the cranial articular process.
Table 4.12. Frequency distribution of cut marks on large bovid lumbar vertebrae. F = filleting, FD = filleting and disarticulation, D = disarticulation, SAF = sawing and filleting, EF = evisceration and filleting, E = evisceration, EFD = evisceration, filleting and disarticulation, CAP = caudal articular process, CE = centrum, CRP = cranial articular process, DP = dorsal spine, TP = transverse process, VA = vertebral arch, WB = whole bone, UCE = upper centrum, LCE = lower centrum.

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4.3.7. SACRUM

4.3.7.1. Small Bovids

Butchery activities associated with the sacrum include evisceration, filleting, and disarticulation. Evisceration was always completed before butchery commenced. Filleting includes the removal of the small flat muscles at the base of the back as well as the tenderloins and sirloins. Disarticulation includes separating the sacrum from lumbar vertebrae, the sacrum from caudal vertebrae, and the sacrum from the pelvis. Figures 4.96 and 4.97 show cut marks produced by all butchery activities.
4.3.7.1.1. Evisceration

The posterior tissues of the lower viscera are associated with the sacrum. Since this part is obscured during evisceration it is very difficult to determine exactly where the butcher was impacting bone. Nevertheless, cutting actions during this activity were longitudinal to diagonal with respect to the long axis of the axial skeleton. The cutting edge was held more or less perpendicular to the bone surface. A single cut mark was produced by this activity and is the long longitudinal cut on the centrum of the sacrum in Figure 4.98(a). This mark is included in the filleting marks in Table 4.13.

4.3.7.1.2. Removing the sirloins

The small flat muscles at the base of the back were removed by making longitudinal cuts on either side of the dorsal spine of the sacrum. These muscles were then lifted and the knife was inserted under them from either the medial or lateral side depending on the side being filleted and possibly the handedness of the butcher. Diagonal to transverse cuts were made with the knife held at an acute angle with the bone surface. To remove the sirloins, longitudinal cuts were made from the base of the back (sacrum) to the base of the neck (last few cervical vertebrae). The sirloins were then lifted and the knife was inserted under them from either the medial or lateral side depending on the side being filleted and the handedness of the butcher. Diagonal to transverse cuts were made between the muscles and underlying bone with the knife held at an acute angle with the bone surface. The muscles were worked loose from the rear to the front of the animal. Only one cut mark was recorded which might represent either the removal of the small flat muscles or the sirloins (Figure 4.97).

4.3.7.1.3. Removing the tenderloins or fillets

This procedure is described above in section 4.3.6.1.2. Cutting actions were almost exclusively longitudinal to diagonal to the long axis of the axial skeleton and made towards the ventral surfaces of the sacrum wings. Cut mark types include cuts and slices. Cut marks produced by tenderloin removal are presented in Figure 4.98. The longitudinal cut on the centrum in Figure 4.98(a) was produced by evisceration. Table 4.13 indicates that the vast majority of cut marks produced by filleting are located on sacrum wings.
4.3.7.1.4. **Disarticulating the sacrum from lumbar vertebrae**

A description of this activity is given above in section 4.3.6.1.5. Transverse cut marks relative to the long axis of the axial skeleton are located adjacent to the cranial articular processes. Cut marks consist of cuts and slices though one shave/cut was recorded. Figure 4.99 shows cut marks associated with disarticulation. Table 4.13 shows that all cut marks are located on the cranial articular process.

4.3.7.1.5. **Disarticulating the sacrum from the pelvis**

A full description of this activity is given below in section 4.4.6.1.1. No cut marks were produced on small bovid sacra during this activity.

4.3.7.1.6. **Disarticulating the sacrum from caudal vertebrae**

One or two transverse cuts were made between the centra of the sacrum and the first caudal vertebrae. The bones were then snapped and connective tissues cut to separate the sacrum from caudal vertebrae. No cut marks were produced by this activity.

Table 4.13. Frequency distribution of cut marks on small bovid sacra. F = filleting, FD = filleting and disarticulation, D = disarticulation, CE = centrum, CRP = cranial articular process, DP = dorsal spine, SW = sacrum wing.

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<td>5%</td>
</tr>
</tbody>
</table>
4.3.7.2. Large Bovids

Butchery activities observed while processing the sacrum include evisceration, removing the sirloins and tenderloins, disarticulating the rear limb from the axial skeleton, disarticulating the sacrum from lumbar vertebrae, and disarticulating the sacrum from caudal vertebrae. The order in which these activities are described is somewhat arbitrary since variation in the sequence was observed. First, the tenderloins, sirloins, and flanks or belly sheets were loosened from their attachment to the sacrum and rear limb before the latter was disarticulated from the axial skeleton. Normally, the limb was filleted while elements were articulated. Disarticulating the limb into elements does not facilitate filleting. In some cases the rear limb was disarticulated from the axial skeleton by separating the pelvis from the sacrum, but in some cases the rear limb was disarticulated with the sacrum. In these cases the sacrum was sawn sagitally and disarticulated from the lumbar vertebrae by sawing through either the cranial part of the sacrum or the caudal part of the lumbar vertebrae. Figures 4.100 and 4.101 display the location of cut marks produced by all butchery activities.

4.3.7.2.1. Evisceration

The rectum and associated soft tissues are associated with the sacrum. These tissues were removed before butchery commenced. For the most part the butcher’s hand was obscured during this procedure and therefore a description is not offered. However, it is clear from video footage that all actions affected the ventral surface of the sacrum in the vicinity of the centrum. Figure 4.102 displays cut marks produced by either evisceration or filleting. Because no meat adheres to the ventral surface of the centrum, these marks are almost certainly the result of evisceration rather than filleting. Table 4.14 shows that all evisceration marks are located on the centrum.

4.3.7.2.2. Removing the sirloins

This activity is described above in section 4.3.7.1.2. Cut marks are almost exclusively longitudinal and include cuts, slices, shave/cuts, shaves, and punctures. Cut marks are restricted to dorsal spines and vertebral arches as displayed in Figures 4.103 and 4.104(b). Figure 4.105 displays cut marks produced by either filleting or disarticulation. These marks can not be attributed to a single activity. However, where longitudinal to diagonal, they are likely the result of filleting, whereas transverse cut marks are more likely the result of
disarticulation. Table 4.14 indicates that the vast majority of marks are located on the dorsal spines with very few marks on vertebral arches.

4.3.7.2.3. Removing the tenderloins or fillets

This activity is described above in section 4.3.6.1.2. Cut marks are longitudinal to diagonal to the long axis of the axial skeleton and consist of cuts, slices, shave/cuts, and shaves. Marks are restricted to sacrum wings and centra. The vast majority of marks are on sacrum wings with very few located on the centra (Table 4.14). Figure 4.104(a) and (c) show cut marks produced by removing tenderloins. Figure 4.105(c) displays marks produced by either filleting or disarticulation. However, since these marks are longitudinal to diagonal relative to the long axis of the axial skeleton, they are more likely the result of filleting – disarticulation marks are almost always transverse, particularly when on non-articular surfaces.

4.3.7.2.4. Disarticulating the sacrum from the pelvis

For the most part this procedure was the same as that described for small bovids in section 4.4.6.1.1. Longitudinal cuts were made through the meat at the crotch to expose the pubic symphysis. The flanks, tenderloins, and sirloins were loosened from the rear limbs before the latter were disarticulated from the axial skeleton. The difference between large and small bovids was that in some cases (for large bovids) the pubic symphysis and sacrum were sawn sagitally and disarticulated from the axial skeleton as part of the rear limb. The rear limbs (along with the sacrum) were disarticulated from the lumbar vertebrae by transverse sawing through either the cranial part of the sacrum or the caudal part of lumbar vertebrae before the sacrum was sawn sagitally to separate the two rear limbs. Cut marks adjacent to and on the sacro-iliac joint in Figure 4.106 are in locations associated with disarticulating the rear limb from the axial skeleton. The two upper cut marks in Figure 4.105(b) may be attributed to disarticulation since these cuts are on the edge of the sacro-iliac joint. Table 4.14 indicates that cut marks associated with this activity (D at SW and SIJ) are very few. This is largely due to the fact that, in some cases, the sacrum was detached with the rear limb and not disarticulated from the pelvis.
4.3.7.2.5. *Disarticulating the sacrum from lumbar vertebrae*

This activity is described above in section 4.3.6.2.5. Cut mark types produced by disarticulation include cuts, slices, shave/cuts, and shaves. Very few punctures were recorded. Figures 4.106 and 4.107 display cut marks produced by this activity. Note that cut marks on the sacro-iliac joint and caudal articular processes of the sacrum are not implicated here. Cut marks produced by either filleting or disarticulation are displayed in Figure 4.105. As described in the filleting section, some of these marks can be attributed to a single activity while others remain ambiguous. Unambiguous disarticulation marks occur on the cranial articular processes or immediately adjacent to them. As shown in Table 4.14, the vast majority of disarticulation marks occur on the cranial articular processes with very few marks located at other anatomical locations.

4.3.7.2.6. *Disarticulating the sacrum from caudal vertebrae*

Transverse cuts relative to the long axis of the axial skeleton were made to the ventral surface between the caudal end of the sacrum and the cranial end of the first caudal vertebra. The bones were not snapped and the bones were separated by cutting only. Cut marks produced by this activity are depicted in Figures 4.106 and 4.107 and are restricted to the caudal extent of the sacrum. Table 4.14 shows that disarticulation cuts occur most commonly at the caudal articular process and are rare at other anatomical locations.
Table 4.14. Frequency distribution of cut marks on large bovid sacra. F = filleting, FD = filleting and disarticulation, D = disarticulation, EF = evisceration and filleting, CAP = caudal articular process, CE = centrum, CRP = cranial articular process, DP = dorsal spine, VA = vertebral arch, SW = sacrum wing, SIJ = sacro-iliac joint.

<table>
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<th>SIJ</th>
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<td>5</td>
<td>0</td>
<td>3</td>
<td>4</td>
<td>12</td>
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<tr>
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<td>2</td>
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<td>8</td>
<td>112</td>
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<tr>
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<td>89</td>
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<th>SW</th>
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<td>2%</td>
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4.4. APPENDICULAR SKELETON

4.4.1. SCAPULA

4.4.1.1. Small Bovids

Activities observed during the butchery of scapulae include disarticulating the front limb from the thorax, disarticulating the scapula from the humerus, and filleting. Under normal conditions (when the butcher was defleshing animals for drying meat and the production of sausage) the front limbs were always disarticulated from the thorax prior to filleting. This was done to facilitate filleting and because the limb could more readily be manipulated during filleting. The front limbs were normally filleted with elements still articulated. Figure 4.108 displays all cut marks produced by butchering the scapulae.
4.4.1.1.1. Disarticulating the front limb from the thorax

The radius was held in the left hand, pulling the front limb away from the thorax. The butcher stood at the front of the animal facing the rear and ventral surface of the thorax. Cuts were made between the humerus/scapula and the thorax from the ventral to the dorsal part of the thorax. Cuts were longitudinal to the long axis of the axial skeleton. While cuts were made, the front limb was constantly pulled away from the thorax. At no point did the cutting tool make contact with bone and therefore no cut marks were produced during this activity. Removing the front limb appeared very easy and happened quickly.

4.4.1.1.2. Filleting

A longitudinal cut was made adjacent to the posterior margin of the scapula blade. The front limb was then turned on its side and a cut was made just proximal of the olecranon towards the distal posterior shaft of the humerus. On reaching the bone surface, a longitudinal shave was made from the distal humerus toward the proximal humerus on the posterior surface. The blade of the knife was held at an acute angle with the bone surface. A few of these shaving cuts were made which connected this cut with the one made adjacent to the posterior margin of the scapula blade. These actions freed a large chunk of meat extending from the posterior side of the distal humerus to the posterior edge of the proximal scapula. In the process of removing these muscles, cuts were also made across the posterior surfaces of the articulation between the proximal humerus and distal scapula.

With the lateral surface of the limb facing the butcher, he made multiple longitudinal cuts on the posterior side of the lateral spine of the scapula from the distal to the proximal end. The knife was turned around and the same cuts were made from the proximal to the distal end of the scapula. These cuts freed the muscles that adhere to the posterior surface of the lateral spine. Then the knife was inserted between meat and bone on the lateral scapular blade at the posterior border. The muscles were lifted and transverse to diagonal cuts were made with the blade at an acute angle with the bone surface, freeing the muscles from the lateral blade at the infraspinous fossa. Next, multiple longitudinal cuts were made on the anterior side of the lateral spine from proximal to distal. The knife was held more or less perpendicular to the supraspinous fossa. These cuts freed the muscles adhering to the anterior side of the lateral spine. Part of the muscles at the proximal end was cut loose and transverse to diagonal cuts with the knife at an acute angle with the bone surface were made to remove
this part of the scapular muscles. The muscles were pulled with one hand while cuts were made. Additional longitudinal cuts were made along the anterior side of the lateral spine from the distal to proximal scapula with the knife held more or less perpendicular to the bone surface. The muscles were then pulled away from the lateral spine with the left hand and the knife was turned to a shallow angle with the bone. Cuts were made along the anterior border from distal to proximal. The knife was then turned with the cutting edge facing up and the butcher cut away from him – from proximal to distal. The muscles were then freed from the bone at the distal epiphysis with a few longitudinal to diagonal cuts to the anterior side of the distal epiphysis.

The muscles on the medial surface of the scapula blade were removed by inserting the point of the knife between the muscles and the bone surface. Once a portion of the muscles was free, it was lifted and diagonal, transverse, to longitudinal cuts were made with the knife at a very shallow angle with the bone surface. These muscles were freed with cuts from both proximal to distal and distal to proximal. The knife was constantly turned from the normal position to upside down. Cut marks produced by filleting include cuts, slices, shave/cuts, and shaves. Cut marks produced during filleting are depicted in Figure 4.108. Table 4.15 shows that the majority of cut marks are located on the shaft (see Figure D.11 for anatomical portions of the scapula) while a considerable number of marks occur on the distal shaft or neck of the scapula. Some filleting marks occur at the distal epiphyses.

4.4.1.1.3. Disarticulating the scapula from the humerus

Before making any cuts the butcher located the joint by levering the bones with one hand while feeling for the joint with the other. After the joint was located, transverse cuts relative to the long axis of the limb were made on the lateral surface toward the articulation between the distal scapula and proximal humerus. The knife was held perpendicular to the joint, but not necessarily to the bone surfaces. After the meat was cleaved and the articular surfaces exposed, the bones were pulled apart and connective tissues severed to separate the scapula from the humerus. The joint is very ‘open’ and loose, making disarticulation easy to complete without cutting against bone. Only one scapula was disarticulated from the humerus and no cut marks were produced by this activity.
Table 4.15. Frequency distribution of cut marks on small bovid scapulae. F = filleting, SH = shaft, DS = distal shaft, DE = distal epiphysis (see Figure D.11 for anatomical portions of the scapula).

<table>
<thead>
<tr>
<th>Activity</th>
<th>SH</th>
<th>DS</th>
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</tr>
</thead>
<tbody>
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<td>266</td>
</tr>
<tr>
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<td>45</td>
<td>16</td>
<td>266</td>
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</table>

<table>
<thead>
<tr>
<th>Activity</th>
<th>SH</th>
<th>DS</th>
<th>DE</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>F</td>
<td>77%</td>
<td>17%</td>
<td>6%</td>
<td>100%</td>
</tr>
<tr>
<td>Total</td>
<td>77%</td>
<td>17%</td>
<td>6%</td>
<td>100%</td>
</tr>
</tbody>
</table>

4.4.1.2. Large Bovids

Butchery activities observed while processing scapulae include disarticulating the front limb from the thorax, filleting, and disarticulating the scapula from the humerus. The front limb was always detached from the thorax to facilitate filleting and to allow more than one person to fillet the limb. It appeared easier to manipulate the limb when disarticulated from the thorax and meat associated with the medial side of the limb is not readily accessed prior to disarticulation. Unless I requested further disarticulation, the front limb was always filleted with the elements articulated. Disarticulating the scapula from the humerus was not normally carried out when an animal was defleshed because this procedure does not facilitate filleting. Additionally, because several muscles extend distally from the scapula across the joint to the humerus, it is easier to remove these muscles with the elements articulated. Figures 4.109 and 4.110 display cut marks produced by all butchery activities.

4.4.1.2.1. Disarticulating the front limb from the thorax

This procedure was the same as that described above for small bovids in section 4.4.1.1.1. However, in processing large bovids the butcher relied on a second person to pull the forelimb away from the thorax while he made cuts between the forelimb and the thorax. The limb was constantly pulled laterally while cutting between it and the thorax. Compared
with small bovids, more cutting actions were required to disarticulate the front limbs of large bovids. No cut marks were produced by this activity.

4.4.1.2.2. Filleting

Procedures employed for defleshing large bovid scapulae were very similar to those described for small bovids in section 4.4.1.1.2. The most significant difference was that many more cutting actions were used for large bovids and the knife was turned more frequently. Most cutting actions were diagonal to longitudinal to the long axis of the scapula with the cutting edge most commonly held at an angle with the bone surface. When cutting along the margins of the scapula the cutting edge was at a very shallow angle with the bone surface. Having reviewed the butchery footage, there is no doubt that the distal epiphyses of scapulae were impacted during filleting. Nevertheless, filleting actions were most often diagonal to longitudinal with the cutting edge at an angle with the bone surface whereas disarticulation was mostly transverse with the cutting edge perpendicular to the bone surface. Therefore, in many cases it should be possible to attribute cut marks at the distal epiphysis to a single activity. Cut mark types produced during filleting include cuts, slices, cut/shaves, and shaves. Very few puncture marks were recorded. Cut/shaves and shaves are more frequent on the medial surface of the scapula blade and along the posterior border. Overall, slices and cuts are more numerous, particularly on the lateral surface of the scapula blade.

Cut marks produced by filleting are displayed in Figures 4.111 and 4.112. Cut marks produced by either filleting or disarticulation are presented in Figures 4.113 and 4.114. However, as noted above and as described in the disarticulation section, certain marks in the latter two figures can in some cases be attributed to a single activity. In locations where both filleting and disarticulation may impact bone, the orientation and angulation of cut marks are crucial to assigning butchery activity. Table 4.16 shows that nearly 80% of cut marks produced during filleting alone are located on the shaft, with only 19% and 4% at the distal shaft and distal epiphysis respectively. In sharp contrast, when bones were filleted and disarticulated, the frequencies of cut marks are more or less evenly distributed across anatomical portions with slightly higher numbers at the distal shaft.
4.4.1.2.3. Disarticulating the scapula from the humerus

As mentioned above this activity was not normally performed when defleshing animals for drying meat or for making sausage. Before any cuts were made the bones were moved around to locate the joint. The butcher also searched for the joint by hand. Transverse cuts relative to the long axis of the joint were made across the medial surface of the limb in the vicinity of the distal scapula and proximal humerus. The meat was cleaved with transverse cuts in the vicinity of the anterior edge of the joint and on the medial side of the limb at the joint. The blade of the butchery tool was held more or less perpendicular to the limb but not necessarily perpendicular to the bone and articular surfaces. Because the bones and joint were covered with meat the butcher could not see the exact location of the articulation. During one disarticulation episode the butcher said that he had cut at the wrong place and had to redirect his cuts after the butchery tool impacted the distal shaft of the scapula. Again the bones were levered to locate the joint. The limb was turned with the anterior surface facing up and transverse cuts relative to the long axis of the joint were made to the anterior surface of the joint. The limb was turned again and cuts were made to the lateral surface in the vicinity of the joint. Again the butcher was working blind due to meat covering the joint and therefore he continued moving the bones to locate the joint. Additional transverse cuts relative to the long axis of the joint were made on the lateral side of the joint, cleaving the meat to expose the articulation between the scapula and the humerus. The bones were moved again to locate the joint. These transverse cuts were directed towards the joint. The limb was turned again with the posterior surface facing up. Transverse cuts were made to the posterior surface and toward the joint, cleaving the meat and exposing articular surfaces. The head of the humerus was exposed and the bones were pulled apart to stretch and expose connective tissues. Connective tissues and meat were then cut to separate the bones. The joint between the scapula and humerus is very loose and if the bones were filleted before disarticulation, the butcher could disarticulate the bones with very little (if any) tool to bone contact.

Although Figures 4.113 and 4.114 display cut marks produced by both filleting and disarticulation, some of these marks can be assigned to disarticulation. It is clear from inspecting the video footage that disarticulation activities differ from filleting activities in certain ways and therefore the two activities produce different cut marks. The most significant difference between disarticulation and filleting is that the former relies on transverse cuts made more or less perpendicular to the bone surfaces in the vicinity of the joint. During disarticulation the butcher cut towards the bone surface (across it) as opposed to
along it. Conversely, filleting involves longitudinal to diagonal cutting strokes, which are made, at an angle with the bone surface. During filleting the meat is often shaved from bone – the butcher cuts along the bone surface as opposed to across it. Disarticulation, therefore, results in transverse cut marks consisting mostly of cuts and slices while filleting results in diagonal to transverse cuts which consist of cuts, slices, shave/cuts, and shaves.

Distinguishing filleting from disarticulation marks depends as much on their orientation and angulation as on their anatomical location. Alone, neither orientation and angulation or anatomical locations of cut marks are reliable indicators of their associated butchery activity. Cut marks which are unambiguously associated with disarticulation are those located at the distal shaft and distal epiphysis in Figure 4.113(a), the transverse cut marks on the distal shaft in Figure 4.113(d), and the cut marks on the medial and lateral articular edges of the glenoid cavity in Figure 4.114. The latter marks were never produced during filleting (see Figure 4.112). Table 4.16 shows that when only filleting was conducted, 4% of the cut marks were produced at the distal epiphysis and 19% at the distal shaft. In contrast, when both filleting and disarticulation were performed, 29% of the cut marks were produced at the distal epiphysis and 38% at the distal shaft.

Table 4.16. Frequency distribution of cut marks on large bovid scapulae. F = filleting, FD = filleting and disarticulation, SH = shaft, DS = distal shaft, DE = distal epiphysis.

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4.4.2. HUMERUS

4.4.2.1. Small Bovids

Activities associated with butchering the humerus include filleting, disarticulating the humerus from the scapula, and disarticulating the humerus from the radio-ulna. Normally the humerus was filleted while the front limb was still fully articulated. Figures 4.115 and 4.116 depict cut marks produced by all butchery activities.

4.4.2.1.1. Filleting

A cut was made just proximal of the olecranon towards the distal posterior shaft of the humerus. On reaching the bone surface, a longitudinal shave was made from the distal humerus toward the proximal humerus on the posterior surface. The blade of the knife was held at an acute angle with the bone surface. A few of these shaving cuts were made which connect this cut with the one made adjacent to the posterior margin of the scapula blade (described in section 4.4.1.1.2). These actions freed a large piece of meat extending from the posterior side of the distal humerus to the posterior edge of the proximal scapula. In the process of removing these muscles, cuts were also made across the posterior surfaces of the articulation between the proximal humerus and distal scapulae. Removing more meat from the humerus on the lateral to posterior side, longitudinal shaves were made both from proximal to distal and from distal to proximal. Some of these cuts may impact the olecranon, where muscles were freed distally. Removing meat on the lateral to anterior side of the humerus, longitudinal cuts were made with the knife held at a shallow angle with the bone surface. These muscles run across the articulation between the distal humerus and proximal radio-ulna and were removed as a unit. The entire muscle mass stretching from the distal radio-ulna to the proximal humerus was removed as a unit.

Longitudinal shave marks are expected to occur from the proximal humerus, over the articulation between the distal humerus and proximal radio-ulna, down to the mid to distal shaft of the radio-ulna. Cut marks produced during filleting include cuts, slices, shave/cuts, and shaves. Figures 4.117 and 4.118 display cut marks produced by filleting. Cut marks are most numerous on the shaft, particularly on the lateral and posterior surfaces. Numerous cut marks occur on the proximal epiphysis (in fact more cut marks occur there than on the proximal shaft) and are present on articular surfaces. Although cut marks occur at the distal
epiphysis, they were not observed on articular surfaces. Table 4.17 indicates that the majority of cut marks occur on the mid and distal shaft, followed by the proximal epiphysis. Fewer marks occur on the proximal shaft and very few filleting marks are located on the distal epiphysis.

4.4.2.1.2. Disarticulating the humerus from the scapula

A full description of this activity is given above in section 4.4.1.2.3. No cut marks on the proximal humerus can unambiguously be assigned to disarticulation since the anatomical placement of cut marks produced by both filleting and disarticulation overlap (Figures 4.119 and 4.120).

4.4.2.1.3. Disarticulating the humerus from the radio-ulna

The butcher located the joint by hand while levering the bones. After locating the joint, transverse cuts relative to the long axis of the joint were made to the lateral surface in the vicinity of the distal humerus and proximal radio-ulna. These cuts were extended to the anterior surface of the joint. From the video footage it is clear that these cuts impact the anterior articular surfaces of the distal humerus. After the articular surfaces were exposed, cuts were made from proximal to distal along the posterior margin of the olecranon with the knife held at a very shallow angle with the bone surface. These cuts were extended down to the vicinity of the articulation between the distal humerus and proximal radio-ulna. These cuts are likely to impact the distal posterior surfaces of the humerus on either side of the coronoid fossa. The bones were pulled apart and connective tissues and flesh were severed to separate the elements. Most disarticulation cuts are cuts and slices. Four marks are shave/cuts and one is a shave. Figures 4.119 and 4.120 show cut marks made by either filleting or disarticulation. Having reviewed the video footage several times I am confident that all cut marks in these figures, with the exception of two clusters, are the result of disarticulation. The exceptions include the lowest two cut marks in Figure 4.119(c) and the lowest two cut marks in Figure 4.119(d). These cuts may be the result of either disarticulation or filleting. Table 4.17 shows that the vast majority of disarticulation cuts are located on the distal epiphysis with only one mark located on the distal shaft.
Table 4.17. Frequency distribution of cut marks on small bovid humeri. F = filleting, FD = filleting and disarticulation, PE = proximal epiphysis, PS = proximal shaft, MS = mid shaft, DS = distal shaft, DE = distal epiphysis.

<table>
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<tr>
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<th>DS</th>
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<th>Total</th>
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4.4.2.2. Large Bovids

Butchery activities observed while processing the humerus include filleting, disarticulating the humerus from the scapula, and disarticulating the humerus from the radio-ulna. The latter two activities were not normally carried out when animals were defleshed for drying meat and making sausage. When the limbs were disarticulated, the latter was completed before filleting commenced. The order in which activities are described below does not imply butchery sequence, but filleting is described first since, unless I requested disarticulation, limbs were always filleted with articulated elements. Cut marks produced by all activities are depicted in Figures 4.121 and 4.122.

4.4.2.2.1. Filleting

This activity was very similar to that described above for small bovids in section 4.4.2.1.1 except that many more cutting strokes were applied and considerably more time was taken to complete the task. Additionally, the knife was turned more frequently and cuts were made both from proximal and distal ends. Cutting stokes were predominantly longitudinal to diagonal with respect to the long axis of the humerus except at the distal shaft. Here several transverse cutting actions were observed both on the anterior and posterior surfaces of the bone. The cutting edge of the butchery tool was almost always held at a shallow angle with
the bone surface. This observation is borne out by the large numbers of cut/shaves and shave marks displayed in Figures 4.123 and 4.124. Video footage reveals that both proximal and distal epiphyses were cut during filleting. However, filleting actions were commonly made longitudinal to diagonal to the long axis of the bone and with the cutting edge at an angle with the bone surface. In contrast, disarticulation actions were almost always transverse to the long axis of the bone with the cutting edge perpendicular to the bone surface. Therefore, based on orientation and angulation, it should be possible to attribute single activities to certain cut marks at both proximal and distal epiphyses. Nevertheless, where angulation of cut marks at epiphyses can not be established, such marks can not be attributed to single activities.

Cut mark types produced during filleting include shave/cuts, shaves, slices, and cuts. Very few puncture marks were recorded. The distribution of filleting marks is displayed in Figures 4.123 and 4.124. Cut marks produced by either filleting or disarticulation are presented in Figures 4.125 and 4.126. As noted above and described in the disarticulation sections, certain marks at epiphyses in the latter two figures may be attributed to single activities. However, activities related to some marks at epiphyses will always remain ambiguous. Table 4.18 shows that filleting alone produces nearly as many cut marks at the proximal epiphysis as at the distal shaft. More cut marks are located at the proximal epiphysis than at either the proximal and mid shaft. A significant number of cut marks are located at the distal epiphysis. When bones were filleted and disarticulated, cut marks are most numerous at the distal epiphysis. This is because the articulation between the distal humerus and proximal radio-ulna is very tight and strong and requires considerable effort to disarticulate.

4.4.2.2. Disarticulating the humerus from the scapula

This activity is described above in section 4.4.1.2.3. There is significant overlap in the anatomical location of cut marks produced by filleting, and filleting and disarticulation as depicted in Figures 4.123 and 4.124, and Figures 4.125 and 4.126 respectively. The most evident difference between disarticulation and filleting marks is that the former activity tends to produce more transverse marks relative to the long axis of the bone than the latter. Disarticulation also tends to produce more cuts and slices, whereas filleting produces more shave/cuts and shaves. The reason for the overlap in anatomical location of disarticulation and filleting marks is that the joint between the scapula and humerus is a very open one.
Therefore the proximal epiphysis and its articular surfaces are exposed to the cutting edge during filleting.

Distinguishing disarticulation from filleting marks depends more on the orientation and angulation of marks than on their anatomical location. However, it may be more difficult determining angulation of marks produced by stone tools than those produced by metal tools. This is due to the fact that stone tools made on coarse textured raw material may not have very sharp cutting edges and may therefore not produce cut mark features used for determining angulation. Table 4.18 shows that similar proportions of cut marks are produced at the proximal epiphysis by both filleting, as well as disarticulation and filleting. In fact, more marks are produced at the proximal epiphysis during filleting than during filleting and disarticulation. However, when viewing the overall distribution of marks produced by the two groups of activities, it is clear that filleting marks are distributed more or less evenly at the proximal epiphysis, proximal shaft, and mid shaft. In contrast, filleting and disarticulation tend to produce more cut marks at the proximal epiphysis than at the proximal and mid shaft.

4.4.2.2.3. Disarticulating the humerus from the radio-ulna

The bones were levered to locate the position of the joint before any cuts were made. The butcher also examined the joint by hand. Transverse cuts relative to the long axis of the joint were made across the entire lateral surface toward the articulation between the distal humerus and proximal radio-ulna. The meat was cleaved by these cuts from anterior to posterior. The bone was turned and the meat was further cleaved on the medial surface of the limb. These transverse cuts were also made toward the joint in the vicinity of the medial condyles of the distal humerus. These cuts were predominantly made into the anterior surfaces of the joint. The cuts were all transverse to the joint and the blade of the knife was held perpendicular to the joint but not necessarily perpendicular to bone and articular surfaces. The limb was turned over again and transverse cuts relative to the long axis of the joint were made to the lateral surface in the vicinity of the joint. The limb was turned again, and stood with the olecranon facing up. Cuts were made just behind the proximal part of the olecranon and down toward the articulation between the proximal radio-ulna and distal humerus. Meat adhering to the posterior surface of the olecranon was cleaved. It did not appear that the bone was cut during this activity.
The limb was laid down again and cuts were made in the vicinity of the anterio-medial surface of the olecranon. These cuts were longitudinal to diagonal to the long axis of the olecranon. Additional transverse cuts were made towards the medial surfaces of the joint. More cuts were made just above the distal epiphysis of the humerus on the posterior surface. These cuts were made towards the distal humerus and between the olecranon and the posterior articular surfaces of the distal humerus. The bones were then levered apart and remaining connective tissues and flesh were severed from the medial and lateral sides to separate the elements. Although Figures 4.125 and 4.126 include cut marks made on bones which were filleted and disarticulated, video footage allowed attributing certain cut marks to disarticulation. When considering the location of cut marks at the distal epiphysis, the reader will note that there is significant overlap in the anatomical placement of cut marks produced during filleting only (Figures 4.123 and 4.124) and those produced during filleting and disarticulation (Figures 4.125 and 4.126).

Disarticulation cuts differ from filleting cuts in that the former are located on the mid to distal part of the medial condyle, and on the anterior edges of the lateral condyle. Filleting cuts are clustered at the proximal anterior edge of the medial condyle and the mid to posterior edges of the lateral condyle. During disarticulation, cuts are made directly toward the bone and articular surfaces, whereas cuts made during filleting are mostly made along the bone surfaces – bone is avoided – and muscles, for the most part, are shaved from the bone. Disarticulation marks, therefore, differ from filleting marks in that the former consist mostly of cuts and slices made more or less perpendicular to the bone surfaces. Filleting marks are more varied and consist predominantly of shave/cuts and slices. No disarticulation cuts occur on the medial epicondyle, but filleting marks do. Table 4.18 shows that filleting and disarticulation produce a significantly higher proportion of cut marks at the distal epiphysis than filleting. The majority of cut marks produced by filleting and disarticulation are located at the distal epiphysis. This is due to the fact that the joint between the distal humerus and proximal radio-ulna is tight and requires numerous cutting strokes for disarticulation. In contrast, the smallest number of cut marks produced during filleting are located at the distal epiphysis.
Table 4.18. Frequency distribution of cut marks on large bovid humeri. F = filleting, FD = filleting and disarticulation, PE = proximal epiphysis, PS = proximal shaft, MS = mid shaft, DS = distal shaft, DE = distal epiphysis.

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4.4.3. RADIUS

4.4.3.1. Small Bovids

Butchery activities observed while processing radii include disarticulating the radio-ulna from the metacarpal, skinning, filleting, and disarticulating the radio-ulna from the humerus. The latter activity was not normally carried out while defleshing animals because it does not facilitate filleting. Cut marks produced by all butchery activities are depicted in Figures 4.127 and 4.128.

4.4.3.1.1. Disarticulating the radio-ulna from the metacarpal

A full description of this activity is given below in section 4.4.5.1.1. Disarticulation cuts were always transverse and made against the carpal bones. I never observed disarticulation actions that were likely to produce cut marks on the distal radius. No cut marks were produced on the radius during this activity.
4.4.3.1.2. Skinning

More detail on skinning is given in sections 4.2.2 and 4.4.5.1.2. The transverse circular cuts made to disarticulate the metacarpal from the distal radio-ulna doubled as skinning cuts, creating access points from where skinning could proceed. The skin at the distal radio-ulna/carpals was lifted and the knife inserted upside down. This was done to prevent contact with bone. A series of cuts with the knife held upside down were made along the medial surface of the fore limb from the distal radius to the sternum where this incision intersected the skinning incision running along the mid-line of the animal on the ventral surface. For more detail on the latter see the description of skinning in section 4.2.2. The skin was pulled away from the proximal medial surface of the front limb and cuts were made against the inner surface of the skin from proximal to distal. These cuts freed the skin from the medial surface of the limb. Cuts were mostly longitudinal to the long axis of the limb, but some diagonal cuts were observed.

After the skin was freed from the medial surface, a few cuts were made to the distal lateral surface before the skin was pulled from the lateral surface of the limb from proximal to distal. No cuts were applied to free the skin from the lateral surface of the radio-ulna. From the video footage it is clear that no cut marks (with the exception of one described below) impact bone along the shaft of the radius as cuts were made against the skin. Additionally, soft tissues protect the bone surface. Although skinning and filleting was performed on radii, inspection of the video footage showed that all cut marks, except one, presented in Figure 4.129 were produced by filleting. The exception is the cut mark at the distal epiphysis on the lateral surface (Figure 4.129(c)). This cut mark was most likely produced by loosening the skin from underlying tissues before it was pulled free from the lateral surface of the limb. Similarly, the values shown in the skinning and filleting (SF) category of Table 4.19 are associated with filleting, except for the SF mark at the distal epiphysis (DE).

4.4.3.1.3. Filleting

Removing meat on the lateral to anterior side of the humerus, longitudinal cuts were made with the knife held at a shallow angle with the bone surface. Muscles run across the articulation between the distal humerus and proximal radio-ulna and were removed in one piece. Therefore, cuts were made on the lateral to anterior side with the knife at a shallow angle with the bone surface from the distal to proximal radio-ulna. The muscles were pulled
away and worked free with further shaving and cutting from distal to proximal. The knife was constantly turned from the normal position to upside down. Muscles on the lateral side and posterior surface of the radio-ulna were also removed by pulling muscles away from the bone while making longitudinal shaves with the knife blade held at an acute angle with the bone surface. Muscles were freed at the distal end of the radio-ulna by cutting away from the bone, into and through muscles. On the posterior surface of the radio-ulna longitudinal cuts were made and muscles were freed from the olecranon by longitudinal cuts from both proximal to distal and distal to proximal. The entire muscle mass stretching from the distal radio-ulna to the proximal humerus was removed as one unit. Longitudinal shave marks are expected to occur from the proximal humerus, over the articulation between the distal humerus and proximal radio-ulna, down to the mid to distal shaft of the radio-ulna.

As described above in 4.4.3.1.2, all except one cut mark in Figures 4.129 and 4.130 were produced during filleting. Contrary to my expectation, most of the marks are slice and cut marks with only a few cut/shave marks. Figures 4.129 and 4.130 show that most cut marks occur on the medial, anterior, and lateral surfaces of the radius with only two marks located on the posterior surfaces. Additionally, cut marks are clustered on the distal shaft of the radius as indicated in Table 4.19 with fewer marks on the mid shaft. No filleting marks are located on the proximal or distal epiphyses. Multiple shaving actions described above did not impact bone. Clustering of filleting cut marks on the distal shaft of the radius can be explained by the fact that this is the distal extent of the meaty part of muscles on the radius.

4.4.3.1.4. Disarticulating the radio-ulna from the humerus

A full description of this activity is given above in section 4.4.2.1.3. Figure 4.131 shows the location of disarticulation marks. One of each of the following is represented; cut or slice mark, shave/cut mark, and shave mark. Two cuts are on the articular surface while one cut is just below the articular surface. As expected from the disarticulation actions described above in section 4.4.2.1.3, all cut marks are located on the anterior side of the bone. Table 4.19 shows that all disarticulation marks are at the proximal epiphysis.
Table 4.19. Frequency distribution of cut marks on small bovid radii. F = filleting, D = disarticulation, SF = skinning and filleting, PE = proximal epiphysis, PS = proximal shaft, MS = mid shaft, DS = distal shaft, DE = distal epiphysis.

(a)  
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<th>DS</th>
<th>DE</th>
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<td>68%</td>
<td>3%</td>
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</tbody>
</table>

4.4.3.2. Large Bovids

Activities observed during the processing of radii include disarticulating the radio-ulna from the metacarpal, skinning, filleting, disarticulating the radio-ulna from the humerus, and sawing and filleting. Disarticulating radio-ulnae from humeri was not normally carried out when processing animals for drying meat and making sausage – the limb was normally defleshed whole with the exclusion of the metacarpal. Sawing through bones was only conducted on a few occasions when portions of the limb were prepared for stewing. This activity was not performed to facilitate filleting and its placement below does not imply sequence of butchery. Figures 4.132 and 4.133 display cut marks produced by all butchery activities.

4.4.3.2.1. Disarticulating the radio-ulna from the metacarpal

This activity is described below in section 4.4.5.2.1. No cut marks were produced on the distal radius during disarticulation.
4.4.3.2.2. *Skinning*

This procedure was the same as that described above for small bovids in section 4.4.3.1.2 (see additional sections referred to in section 4.4.3.1.2) although more cutting actions were employed when skinning large bovids. In some cases skinning was initiated at the distal shaft of the radius where transverse circular cuts were made to the anterior, medial, and lateral surfaces of the distal radius. In some cases these cuts were made around the entire circumference of radio-ulnae. After the skin was pierced it was worked free in the same fashion as described above for small bovids. Some transverse cuts at the distal shaft of the radius as depicted in Figure 4.134 may be the result of skinning, but attributing these marks to a single activity is ambiguous. Although marks depicted in Figures 4.135 and 4.136 were produced by either skinning, filleting, or disarticulation, it is more likely that these marks are the result of the latter two activities since during skinning the butcher was usually cutting against the inner surface of the skin and therefore not impacting bone. Table 4.20 includes skinning in the activity column, but it is not possible to attribute marks in these categories to a single activity. The vast majority of skinning and filleting (SF) marks are most likely the result of filleting.

4.4.3.2.3. *Filleting*

The same butchery procedures as described above for small bovids in section 4.4.3.1.3 were used to deflesh large bovid radii. However, many more cutting actions were applied to large bovid radii and considerably more time was required to complete the task when compared to small bovids. Defleshing cuts were commonly diagonal to longitudinal with respect to the long axis of the bone and with the cutting edge held at a shallow angle with the bone surface. However, transverse cutting motions were observed toward the mid and distal shaft. At the latter localities the butcher was cutting the distal extremities of muscles and their associated tendons. The butcher often turned the cutting edge away from the bone to cut through tendons, but transverse cuts with the cutting edge perpendicular to the bone surface were also observed. Cut mark types include cuts, slices, shave/cuts, and shaves. Very few puncture marks were recorded. Cut marks produced by skinning and filleting are presented in Figures 4.134 and 4.135.

In many cases filleting marks can be distinguished from those produced by skinning. Skinning slices and cuts are transverse to the long axis of the bone and made more or less
perpendicular to the bone surface where the skin was initially pierced. After the skin was pierced, it was pulled away from the bone and cutting actions were most commonly applied to the inner surface of the skin to sever subcutaneous tissues. On the other hand, filleting actions were more commonly longitudinal to diagonal with respect to the long axis of the bone and the cutting edge was held at a shallow angle with the bone surface. However, as mentioned above, transverse skinning actions were observed and therefore certain transverse cuts at the distal shaft of the radius can not be attributed to a single activity. From the butchery footage, it is expected that skinning marks will generally not impact the radius at the mid and proximal shaft or the proximal epiphysis. In contrast, filleting certainly affects these areas. The cut marks in Figure 4.135(a) are in an unusual location for either skinning or filleting. Observations show that skinning could not have produced these marks. However, they are also in a peculiar location from a filleting perspective. A plausible explanation for these cuts is that they were produced during filleting after the humerus was disarticulated from the radio-ulna. The latter activity would have exposed these articular surfaces, which were then cut ‘accidentally’ while filleting the radius. There is no doubt that filleting cutting actions impacted the proximal epiphysis and these actions were in some cases transverse to the long axis of the bone. However, when it is not possible to determine the angulation of cuts, the behavioural correlates of some cut marks at the proximal epiphysis remain ambiguous. Table 4.20 indicates that skinning and filleting marks are most numerous at the mid shaft, followed by the proximal and distal shaft. Considerably fewer marks are located at proximal and distal epiphyses.

4.4.3.2.4. Disarticulating the radio-ulna from the humerus

This activity is described above in section 4.4.2.2.3. Cut marks produced by this activity are restricted to the proximal epiphysis (Figure 4.137). Cut marks are mostly transverse to the long axis of the bone and were made more or less perpendicular to the bone surface, resulting in cuts and slices. Although cut marks depicted in Figure 4.136 were produced by either skinning, filleting, or disarticulation, they are more likely the result of filleting. The improbability of them being skinning marks is described above. The mark at the proximal epiphysis is longitudinal to diagonal and therefore not likely the result of disarticulation since the latter relies on transverse cutting actions. The other two marks are shave/cuts, which are not normally produced by disarticulation. Table 4.20 shows that all disarticulation marks are located at the proximal epiphysis.
4.4.3.2.5. Sawing

This activity was performed on one specimen. The bones were sawn in preparation for stewing. The saw mark is depicted in Figure 4.138.

Table 4.20. Frequency distribution of cut marks on large bovid radii. D = disarticulation, SAF = sawing and filleting, SF = skinning and filleting, SFD = skinning, filleting and disarticulation, PE = proximal epiphysis, PS = proximal shaft, MS = mid shaft, DS = distal shaft, DE = distal epiphysis.

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4.4.4. ULNA

4.4.4.1. Small Bovids

Butchery activities observed for processing ulnae include disarticulating radio-ulnae from metacarpals, skinning, filleting, and disarticulating radio-ulnae from humeri. The latter was not normally carried out while filleting animals. Figure 4.139 depicts cut marks produced by all butcherly activities.
4.4.4.1.1. Disarticulating the radio-ulna from the metacarpal

A full description of this activity is given below in section 4.4.5.1.1. Disarticulation cuts were always transverse and made against the carpal bones. I never observed disarticulation actions that were likely to impact distal ulnae and no cut marks were recorded.

4.4.4.1.2. Skinning

See the description above in section 4.4.3.1.2. As described for radii, skinning did not produce cut marks on the ulna. Therefore, although both skinning and filleting were carried out on all ulnae, filleting produced all cut marks displayed in Figure 4.140. Similarly, values in the SF category of Table 4.21 represent filleting.

4.4.4.1.3. Filleting

Removing meat from the humerus on the lateral to posterior side, longitudinal shaves were made both from proximal to distal and from distal to proximal. Some of these cuts may impact the olecranon, where muscles were freed distally. Removing meat on the lateral to anterior side of the humerus, longitudinal cuts were made with the knife held at a shallow angle with the bone surface. These muscles run across the articulation between the distal humerus and proximal radio-ulna and were removed in one piece. Therefore, cuts were made with the knife at a shallow angle with the bone surface from the distal to proximal radio-ulna. The muscles were pulled away and worked free with further shaving and cutting from the distal to proximal radio-ulna. The knife was constantly turned from the normal position to upside down. Muscles on the lateral side and posterior surface of the radio-ulna were also removed by pulling muscles away from the bone while making longitudinal shaves with the knife blade held at an acute angle with the bone surface. The muscles were freed at the distal end of the radio-ulna by cutting away from the bone, into and through the muscles.

On the posterior surface of the radio-ulna longitudinal cuts were made and the muscles were freed from the olecranon by longitudinal cuts from both proximal to distal and distal to proximal. The entire muscle mass stretching from the distal radio-ulna to the proximal humerus was removed as one unit. Longitudinal shave marks are expected to occur from the proximal humerus, over the articulation between the distal humerus and proximal radio-ulna, down to the mid to distal shaft of the radio-ulna. Figure 4.140 displays the location of cut
marks produced by filleting. Overall, filleting the ulnae produced very few marks. This can be explained by the fact that a lot of force is used in pulling muscles free with few cuts applied where the muscles adhere more strongly to the bone surfaces. Unexpectedly, very few shave marks occur on the ulnae. Cut marks consist mostly of cuts and slices with a few shave/cuts at the proximal ulnae. Table 4.21 shows that most marks occur on the olecranon, a couple on the distal shaft and only one mark on each the mid and proximal shaft.

4.4.4.1.4. Disarticulating the radio-ulna from the humerus

A full description of this activity is given above in section 4.4.2.1.3. Figure 4.141 shows the location of disarticulation marks. All marks occur at the proximal epiphysis (anconeal process) as indicated in Table 4.21 (see Figure D.15 for anatomical portions of the radio-ulna). Cut marks consist predominantly of cuts and slices with only one shave/cut represented. All cuts except two occur on the articular surfaces. The two exceptions occur just proximal of the articular surfaces on the anconeal process. As expected from the disarticulation actions described above in section 4.4.2.1.3, all cut marks are located on the anterior side of the bone.

Table 4.21. Frequency distribution of cut marks on small bovid ulnae. D = disarticulation, SF = skinning and filleting, PE = proximal epiphysis, PS = proximal shaft, MS = mid shaft, DS = distal shaft, DE = distal epiphysis, OL = olecranon.

<table>
<thead>
<tr>
<th>(a) Portion</th>
<th>Activity</th>
<th>PE</th>
<th>PS</th>
<th>MS</th>
<th>DS</th>
<th>DE</th>
<th>OL</th>
<th>Total</th>
</tr>
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<tr>
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<tr>
<td>SF (12)</td>
<td></td>
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<td>1</td>
<td>1</td>
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<td>0</td>
<td>4</td>
<td>8</td>
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<table>
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<th>(b) Portion</th>
<th>Activity</th>
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<th>PS</th>
<th>MS</th>
<th>DS</th>
<th>DE</th>
<th>OL</th>
<th>Total</th>
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<tr>
<td>D</td>
<td></td>
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<td>0%</td>
<td>0%</td>
<td>0%</td>
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<td>0%</td>
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4.4.4.2. Large Bovids

Activities observed during the processing of ulnae were the same as those described above for radii in section 4.4.3.2. Disarticulating radio-ulnae from humeri was not normally carried out when processing animals for drying meat and making sausage. The front limb was normally defleshed whole with the exclusion of the metacarpal. Figures 4.142 and 4.143 display cut marks produced by all butchery activities.

4.4.4.2.1. Disarticulating the radio-ulna from the metacarpal

This activity is described below in section 4.4.5.2.1. Cut marks on the styloid process as depicted in Figure 4.145(b) were produced by this activity. The cutting tool was used perpendicular to the joint, but once the blade penetrated between the articular surfaces, the cutting edge was parallel to the articular surfaces resulting in shave/cut and shave marks. These cuts were not produced by either filleting or skinning, as the tool never penetrated between articular surfaces during these activities. The three marks at the distal epiphysis (DE) in Table 4.22 are disarticulation marks.

4.4.4.2.2. Skinning

Procedures employed were the same as those described above for small bovids in section 4.4.3.1.2 although more cuts were made when skinning large bovids. In some cases skinning was initiated at the distal shaft of radio ulnae where transverse circular cuts were made to the anterior, medial, and lateral surfaces. In some cases these cuts were made around the entire circumference of radio-ulnae. After the skin was pierced it was worked free in the same fashion as described in section 4.4.3.1.2. Some transverse cuts at the distal shaft of the ulna as depicted in Figure 4.146(c) and (d) may have resulted from skinning, but attributing these marks to a single activity is not possible. Although marks depicted in Figures 4.146 and 4.147 were produced by either skinning or filleting, it is more likely that these marks resulted from filleting, because while skinning, the butcher was usually cutting against the inner surface of the skin and therefore not impacting bone. The vast majority of marks in these figures are therefore more likely the result of filleting. Cut marks at the proximal, posterior and anterior surfaces of the olecranon and posterior surfaces of the ulna shaft may be the result of skinning since very thin layers of soft tissue lie between skin and bone. Cut marks on medial and lateral surfaces of the olecranon and ulna shaft are undoubtedly the result of filleting.
Nevertheless, attributing certain marks to a single activity remains somewhat ambiguous. Table 4.22 includes skinning in the activity column, but for reasons mentioned above, it is not possible to attribute all marks in these categories to single activities. The vast majority of SF marks in Table 4.22 are more likely the result of filleting.

4.4.4.2.3. Filleting

   Procedures for filleting large bovid ulnae were very similar to those employed for small bovids as described in section 4.4.4.1.3 except that many more cutting strokes were employed for large bovids and the task required considerably more time. Additionally, the knife was turned often and cutting actions were from both proximal and distal. Filleting actions were exclusively longitudinal to diagonal to the long axis of the bone and the cutting edge of the butchery tool was frequently held more or less perpendicular to the bone surface, particularly on the medial and lateral shafts of the ulna. Butchery effort was most intense at the proximal shaft and the olecranon. Cut marks produced by either skinning or filleting are displayed in Figures 4.146 and 4.147. Cut marks along the shaft of the ulna are undoubtedly the result of filleting. However, cut marks at the olecranon, particularly along the proximal, anterior, and posterior margins are more ambiguous. This is because the skin is tightly bound at these locations and therefore a considerable number of cutting strokes are likely to impact the bone during skinning. Cut marks at the proximal, anterior, and posterior margins can therefore not be attributed to a single activity. Since a considerable amount of meat and soft tissues underlie the skin on the lateral and medial sides of the olecranon, cut marks at these locations can be attributed to filleting rather than skinning. Transverse cut marks at the distal shaft are more likely the result of skinning where the skin was initially pierced. Cut/shaves and shaves at the distal shaft are more likely the result of filleting as the meat was shaved longitudinally from the bone. Cut mark types produced during filleting include cuts, slices, shave/cuts, and shaves. Table 4.22 shows that filleting marks are most numerous at the olecranon followed by the proximal shaft. Considerably fewer marks are located at the mid shaft and distal shaft with no cut marks recorded at proximal and distal epiphyses.

4.4.4.2.4. Disarticulating the radio-ulna from the humerus

   This activity is described above in section 4.4.2.2.3. Although the cut mark in Figure 4.144(a) and (b) was produced by either skinning, filleting, or disarticulation, the overlap of
marks produced by different activities at this location precludes attributing it to a single activity. Cut marks produced by disarticulation are located on the medial edge of the articular surface of the semilunar notch (Figure 4.148(a)). Only two marks were produced at the proximal epiphysis during this activity (Table 4.22) and disarticulation marks do not occur on other anatomical locations or portions.

4.4.4.2.5. Sawing

This procedure is described above in section 4.4.3.2.5. Saw marks are displayed in Figure 4.149. Only two saw marks were recorded (Table 4.22).

Table 4.22. Frequency distribution of cut marks on large bovid ulnae. D = disarticulation, SAF = sawing and filleting, SF = skinning and filleting, SFD = skinning, filleting and disarticulation, PE = proximal epiphysis, PS = proximal shaft, MS = mid shaft, DS = distal shaft, DE = distal epiphysis, OL = olecranon.

<table>
<thead>
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</tr>
</thead>
<tbody>
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</tr>
<tr>
<td>SAF (1)</td>
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</tr>
<tr>
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<tr>
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<table>
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</thead>
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<td>0% 30% 10% 6% 0% 54%</td>
</tr>
<tr>
<td>SFD</td>
<td>0% 0% 0% 0% 75% 25%</td>
</tr>
<tr>
<td>Total</td>
<td>1% 29% 10% 6% 2% 52%</td>
</tr>
</tbody>
</table>
4.4.5. CARPALS

4.4.5.1. Small Bovids

Since no meat is associated with carpal bones, the only activities carried out while processing carpals are disarticulation and skinning. Figure 4.150 displays cut marks made by disarticulation and skinning.

4.4.5.1.1. Disarticulating the metacarpal from the radio-ulna

The butcher felt for the location of the joint between the distal radio-ulna and proximal metacarpal before making cuts. The metacarpal was held in the left hand while transverse cuts were made - perpendicular to the bone surface - to the posterior surfaces of the carpal bones. The cuts were then extended to the medial surfaces, back to the posterior surfaces and extended again to the lateral surfaces of the carpals. The metacarpal along with some carpal bones was then snapped cranially (to the front of the animal), which exposed and stretched connective tissues. Connective tissues were then cut to free the metacarpal with some carpal bones from the distal radius. The latter also retained some carpal bones. In very few instances were disarticulation cuts extended to the anterior surfaces of the carpals as can be seen by the few cut marks illustrated in Figure 4.151(b). Nearly all disarticulation marks are cut marks and only one shave/cut mark was identified. All marks are transverse to the long axis of the joint. Table 4.23 shows that the majority of disarticulation marks occur on the unciform and cuneiform with fewer marks on the scaphoid and lunate. The pisiform was not cut marked.

4.4.5.1.2. Skinning

Disarticulation cuts doubled as skinning marks as disarticulation created points of entry from where skinning could proceed. Skin at the distal radio-ulna/carpals was lifted and the knife inserted upside down between skin and underlying soft tissues and bone. This was done to prevent contact with bone. A cut was made along the medial surface of the fore limb from the distal radius to the sternum where it intersected the skinning incision running the length of the body along the mid-line on the ventral surface. For more detail see the description of skinning above in section 4.2.2. The skin was freed from distal to proximal and from medial to lateral by cutting between skin and underlying tissues. Cutting actions ranged from longitudinal to diagonal. Cuts were mostly made against the inner surface of the skin, but
bone may be cut accidentally where underlying tissues protecting the bone surface are very thin. On the carpals, marks produced by skinning are immediately distinguishable from disarticulation marks in that the former were produced by diagonal to longitudinal cutting actions while the latter were always produced by transverse cutting actions. Figure 4.152 depicts the location of a skinning cut mark on the posterior surface of the lunate. Table 4.23 shows that the only cut mark produced during skinning is located on the lunate. No cut marks were produced on the distal radio-ulna during disarticulation. There are 12 sets or 50 carpal bones included in the analysis. In Table 4.23 I use 12 for the minimum number of elements (MNE).

Table 4.23. Frequency distribution of cut marks on small bovid carpals. D = disarticulation, SD = skinning and disarticulation, UN = unciform, CUUN = cuneiform and unciform, CU = cuneiform, SD = scaphoid, LN = lunate.

(a) | Portion
---|---
| Activity | UN | CUUN | CU | SD | LN | Total |
| D (12) | 9 | 4 | 8 | 6 | 4 | 31 |
| SD (12) | 0 | 0 | 0 | 0 | 1 | 1 |
| Total | 9 | 4 | 8 | 6 | 5 | 32 |

(b) | Portion
---|---
| Activity | UN | CUUN | CU | SD | LN | Total |
| D | 29% | 13% | 26% | 19% | 13% | 100% |
| SD | 0% | 0% | 0% | 0% | 100% | 100% |
| Total | 28% | 13% | 25% | 19% | 16% | 100% |

4.4.5.2. Large Bovids

Activities observed during the butchery of carpals include disarticulating the radio-ulna from the metacarpal and skinning. No meat is associated with these bones and therefore filleting is excluded. The order in which butchery activities are described does not reflect the order in which activities were carried out. In some cases the metapodials were disarticulated before skinning and in other cases skinning was performed before disarticulation. Figure 4.153 depicts cut marks produced by skinning and disarticulation.
4.4.5.2.1. Disarticulating the metacarpal from the radio-ulna

Transverse cuts relative to the long axis of the joint were made to the posterior surfaces of the carpal bones with the knife held perpendicular to the joint but not necessarily to the bone surfaces. These cuts were extended to either the lateral or medial surfaces. In some cases, transverse cuts were made around the entire joint. However, most cutting was applied to the posterior surfaces. These cuts severed some connective tissues. After severing connective tissues and while supporting the distal radius with one hand, the metacarpal was snapped cranially or to the front and twisted either medially or laterally to tear, stretch, and expose connective tissues and articular surfaces. Connective tissues were then cut to free the metacarpal from the radio-ulna. Both the metacarpal and radio-ulna retained some carpal bones. Figure 4.154 displays cut marks produced by disarticulation. These cuts are mostly cut and slice marks although a few cut/shave marks do occur. Table 4.24 shows that most disarticulation cut marks occur on the unciform followed by the magnum, scaphoid, cuneiform, and pisiform. Very few marks occur on the lunate. Some marks extended from one carpal bone to another such as those represented by CUUN and SDMA in Table 4.24.

4.4.5.2.2. Skinning

This activity was the same as that described for small bovids in section 4.4.5.1.2 except that more cutting strokes were applied for large bovids. Skinning actions differ from those used for disarticulation in that the former were mostly longitudinal to diagonal to the long axis of the joint. Skinning cuts, therefore, can be distinguished from disarticulation cuts in that the former are longitudinal to diagonal and the latter are mostly transverse to diagonal. It follows that although cut marks depicted in Figure 4.155 were produced by either skinning or disarticulation, these cuts can be attributed to skinning with reasonable certainty. For reasons mentioned above, cut marks in the SD row of Table 4.24 are attributed to skinning. There are 18 sets or 94 carpal bones included in the analysis. In Table 4.24 I use 18 as the MNE.
Table 4.24. Frequency distribution of cut marks on large bovid carpals. D = disarticulation, SD = skinning and disarticulation, UN = unciform, CUUN = cuneiform and unciform, CU = cuneiform, SD = scaphoid, LN = lunate, MA = magnum, PI = pisiform, SDMA = scaphoid and magnum.

<table>
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<th>Activity</th>
<th>UN</th>
<th>CUUN</th>
<th>CU</th>
<th>SD</th>
<th>LN</th>
<th>MA</th>
<th>PI</th>
<th>SDMA</th>
<th>Total</th>
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<td>7</td>
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<table>
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<th>CUUN</th>
<th>CU</th>
<th>SD</th>
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<th>MA</th>
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<tr>
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<td>1%</td>
<td>21%</td>
<td>13%</td>
<td>2%</td>
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</tr>
</tbody>
</table>

4.4.6. PELVIS

4.4.6.1. Small Bovids

Activities associated with butchering the pelvis include disarticulating the rear limb from the sacrum, filleting, and disarticulating the pelvis from the femur. The rear limb can be defleshed while still attached to the axial skeleton or disarticulated from it. Filleting the rear limb was usually performed with the limb attached to the axial skeleton. Rear limbs were detached for filleting when many animals required processing and more than one butcher was involved in the filleting process. Disarticulation is advantageous because it allows more than one butcher to process an animal. Under normal conditions (when defleshing animals for drying meat and for the production of sausage) the limb was defleshed with the skeletal elements articulated. Muscles lie across articulations and are more readily removed from the bones while elements are articulated. Because all bones were filleted, but only some filleted and disarticulated, this experimental sample offers an opportunity to compare the locations and nature of cut marks produced by filleting only with those produced by a combination of filleting and disarticulation. Since rear limbs were not processed in any particular order, my descriptions of different butchery activities do not imply butchery sequence. Figure 4.156 depicts cut marks produced by all butchery activities.
4.4.6.1.1. **Disarticulating the pelvis from the sacrum**

Before any disarticulation cuts were made the following parts were removed: the sex organs, mammary glands, tenderloins, and sirloins. The small flat muscles at the base of the back in the vicinity of the sacrum were also sometimes removed. The butcher faced the rear of the animal cutting to the ventral surfaces. Longitudinal cuts relative to the long axis of the axial skeleton were made to the pubic symphysis with the blade of the cutting tool held perpendicular to the bone surface. The point of the knife was inserted into the pubic symphysis. Held in the left hand, the knife was hammered into the pubic symphysis with the hard part (in the region of the proximal metacarpals) of the palm of the right hand. Once lodged in the pubic symphysis, the knife was levered back and forth, cutting through the pubic symphysis and splitting the pelvis into two halves. The hammering and levering process was sometimes carried out at more than one point along the pubic symphysis until the pelvis was split. Next the belly sheet or flank was removed from the rear limb by cuts between the posterior margin of the flank and the medial surface of the upper rear limb. Cuts were made to the crotch in the vicinity of the sacro-iliac joint with the knife held longitudinal to diagonal to the long axis of the axial skeleton. The limb was pulled forward while making these cuts and a combination of leverage and cutting separated the pelvis from the sacrum. Cuts to the sacro-iliac joint were made from the rear to the front (cranially). Figures 4.157 and 4.158 depict cut marks associated with disarticulating the rear limb from the axial skeleton. Table 4.25 indicates that all cut marks associated with splitting the pelvis into two halves are located at the pubic symphysis. Disarticulating the pelvis from the sacrum resulted in cut marks in more or less equal numbers at the sacro-iliac joint (SIJ) and near that joint (NE) (Table 4.25).

4.4.6.1.2. **Filleting**

The description of filleting the pelvis is not as detailed as descriptions of filleting other skeletal elements. This is mainly due to the fact that the pelvis is situated between the sacrum and femur, and is therefore difficult to see on the video footage. Additionally, muscles associated with the pelvis are also associated with the sacrum and femur, and these muscles were commonly filleted from the latter two elements before they were freed from the pelvis. Therefore, actions directly impacting the pelvis are very quick, and the locations at which the butcher makes his cuts are very difficult to see because the pelvis is not clearly visible. After
muscles were loosened from the sacrum and femur they were detached from the pelvis by cuts, slices, and shaves made longitudinal to transverse relative to the long axis of the axial skeleton. For the most part the blade of the knife was held at an acute angle with the bone surface. Most cutting actions were applied to the ventral, lateral, and medial surfaces of the element. Because muscles extend from the pelvis to the femur, cuts were made across the articulation between the proximal femur and acetabulum. Therefore, some filleting cuts are located on the edge of the articular surface of the acetabulum. Though cut mark types include cuts, slices, shave/cuts and shaves, this element preserves a considerable number of shave/cuts and shaves. Figure 4.159 depicts the location of cut marks produced by filleting while Figure 4.160 presents the location of cut marks made by either filleting or disarticulation. Table 4.25 indicates that the vast majority of filleting marks occur on the ilium and ischium shafts of the pelvis, but cut marks do occur near and at the epiphyses (see Figure D.18 for anatomical portions of the pelvis).

4.4.6.1.3. Disarticulating the pelvis from the femur

The butcher located the joint with one hand while levering articulated bones with the other hand. This was done before any cuts were made. After the joint was located, transverse cuts relative to the long axis of the joint were made to the medial surface towards the acetabulum and proximal femur. The limb was turned and cuts were made to the posterior surface in the vicinity of the joint. The limb was turned again and transverse cuts were made to the lateral surface of the joint. Again the limb was turned and transverse cuts were made to the anterior surface toward the acetabulum and proximal femur. After the meat was cleaved from all sides and articular surfaces were exposed, the femur was pulled to one side, exposing the accessory and round ligaments that bind the femur head to the acetabulum. The round ligament adheres to the central base of the acetabular fossa and the fovea capitis of the femoral head. With one or two cuts this ligament was severed to disarticulate the pelvis from the femur. For small bovids this activity appears easy because the articulation is not very tight or strong and disarticulation is completed within two minutes. Force and leverage were used to expose the articular surfaces. Figure 4.161 shows cuts produced during disarticulation while Figure 4.160 displays cuts made by either disarticulation or filleting. Table 4.25 shows that both cuts associated with disarticulation are located at the epiphysis on the edge of the acetabulum.
Table 4.25. Frequency distribution of cut marks on small bovid pelves. F = filleting, FD = filleting and disarticulation, D = disarticulation, DPS = disarticulating pelvis from sacrum, SP = splitting pelvis into two halves, SIJ = sacro-iliac joint, SH = shaft, NE = near epiphysis, EP = epiphysis, PB = pubic symphysis.

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<th>NE</th>
<th>EP</th>
<th>PB</th>
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4.4.6.2. Large Bovids

Butchery activities observed while processing the pelvis include disarticulating the rear limb from the axial skeleton (splitting the pelvis into two halves and disarticulating the pelvis from the sacrum), filleting, and disarticulating the pelvis from the femur. The rear limb was always disarticulated from the axial skeleton to facilitate filleting. Normally the rear limb was not disarticulated into elements before filleting. Figure 4.162 displays cut marks produced by all butchery activities.

4.4.6.2.1. **Disarticulating the pelvis from the sacrum**

This procedure was very similar to that described above for small bovids in section 4.4.6.1.1. Before the rear limb was disarticulated the flanks, tenderloins, and sirloins were loosened from the rear limb in the same way as described above for small bovids. Cutting through flesh to expose the pubic symphysis was the same as that described for small bovids.
except that the butcher stood at the rear of the animal. Therefore, longitudinal cuts through flesh and onto the pubic symphysis were made from cranial to caudal with the cutting edge perpendicular to the bone surface. After exposing the pubic symphysis the knife point was hammered into the pubic symphysis and levered back and forth. With the knife inserted in the pubic symphysis it was held in a stabbing grasp and pulled toward the rear of the animal, causing the pelvis to split into two halves. Cut marks consist mostly of cuts and slices though a few cut/shaves were recorded. Cut marks produced by splitting the pelvis are displayed in Figure 4.163. As expected, Table 4.26 shows that all cut marks associated with splitting the pelvis are located at the pubic symphysis.

To separate the rear limb from the sacrum, longitudinal cuts were made from the base of the spine (in the region of the lateral margins of the sacral centrum) on the dorsal surface from caudal to cranial. A second butcher levered the limb laterally and cranially to allow the butcher to cut from caudal to cranial on the dorsal surface between the sacrum and the pelvis. The butcher continued on the ventral surface by making longitudinal cuts in the vicinity of the sacro-iliac joint, cutting from caudal to cranial. A combination of cutting and leverage was used to separate the rear limb from the sacrum. A few additional cuts were made through connective tissue and flesh to free the rear limb from the axial skeleton. Figure 4.164 displays cut marks produced by this activity. Table 4.26 shows that the majority of cuts associated with disarticulating the pelvis from the sacrum (DPS) are located near the epiphysis (NE) – in this case the epiphysis is the sacro-iliac joint (SIJ). The remainder of the DPS cut marks are located at the sacro-iliac joint. In a few cases the sacrum was sawn sagitally and removed along with the rear limb.

4.4.6.2.2. Filleting

Filleting the pelvis was completed in more or less the same manner as described above for small bovids in section 4.4.6.1.2 except that the process required more cutting strokes and time to complete. The cutting tool was turned continuously during butchery and cuts were made from both cranial and caudal as well as lateral and medial. The major reason for the above is that large bovid pelves have significantly more meat associated with them and therefore requires more effort to deflesh. The edges of the acetabulum were often impacted, but the butchery tool was never observed to penetrate the inner articular surfaces of the acetabulum. The surfaces of the sacro-iliac joint were very seldom impacted during filleting.
Cut mark types produced during filleting include cuts, slices, shave/cuts, and shaves. Puncture marks were not recorded. Figure 4.165 displays cut marks produced by filleting while Figure 4.167 depicts cut marks produced by filleting and disarticulation. Clearly there is overlap in the location of marks produced by these two activities in the vicinity of the acetabulum and on the edges of the articular surfaces. These marks can not be attributed to a single activity and therefore behavioural correlates of marks on the edges of, and in the vicinity of the acetabulum, remain ambiguous. Table 4.26 shows that almost 90% of filleting marks occur on the ilium and ischium shafts of the pelvis with a much smaller proportion of cut marks near and at the epiphysis. In contrast, no disarticulation cut marks occur on the shaft of the pelvis.

4.4.6.2.3. Disarticulating the pelvis from the femur

As mentioned above, this activity was not normally carried out when animals were processed for drying meat and for making sausage. Before making any cuts the butcher moved the articulated bones to locate the joint. However, he could only estimate the location of the joint and cuts were therefore directed toward the vicinity of the joint. Because meat obscured the joint the butcher was cutting ‘blindly’ and it is conceivable that he did not cut directly to articular surfaces. However, the meat was cleaved and the bones pulled apart before any actual disarticulation cuts were made. Transverse cuts relative to the long axis of the joint were made across the medial surface of the limb in the vicinity of the articulation between the proximal femur and acetabulum. The butcher was unable to see the joint and the bones were levered again to locate the joint.

The limb was turned to stand on its posterior surface while transverse cuts relative to the long axis of the joint and not necessarily to the bone surfaces were made to the anterior surface, through meat and toward the joint. The blade of the knife was held more or less perpendicular to the joint but not necessarily to the bone or articular surfaces. The limb was turned over and transverse cuts relative to the long axis of the joint were made through the meat on the medial side of the limb and towards the joint. In one case, the butcher cut too high and appeared to have impacted the edges of the acetabulum. Additional transverse cuts were made from all sides of the joint to cleave the meat. These cuts were always directed towards the joint between the femur and pelvis. Once the joint was exposed the meat was cleared around the joint. Cuts were then made directly to the joint. The meat was cleaved
further on the medial surface of the joint, cutting toward the joint. After the meat was cleaved from all sides, transverse cuts were made on the lateral and medial sides directly into the articulation between the femur head and acetabulum. Finally the accessory and round ligaments were severed with a few cuts and the bones separated. Cut marks include cuts, slices, punctures, and a few shave/cuts. Figure 4.166 depicts cut marks produced during disarticulation. Cut marks occur on the articular surfaces of the acetabulum, edges of the acetabulum, and in the area of attachment for muscles just anterior of the acetabular edge (Figure 4.166(a)). Figure 4.167 displays cut marks produced by either filleting or disarticulation. These marks can not be attributed to a single butchery activity. Table 4.26 shows that the vast majority of disarticulation cut marks occur at the acetabulum (EP), with considerably less located near the acetabulum (NE).

Table 4.26. Frequency distribution of cut marks on large bovid pelves. F = filleting, FD = filleting and disarticulation, D = disarticulation, DPS = disarticulating pelvis from sacrum, SP = splitting pelvis into two halves, SIJ = sacro-iliac joint, SH = shaft, NE = near epiphyseal, EP = epiphysis, PB = pubic symphysis.

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4.4.7. FEMUR

4.4.7.1. Small Bovids

Both filleting and disarticulation were documented during butchery of this element. Usually the limb including the femur was filleted in its entirety, but the rear limbs were sometimes disarticulated from the sacrum and processed off the carcass. This allowed more than one butcher to fillet an animal. Figures 4.168 and 4.169 display cut marks produced by all butchery activities.

4.4.7.1.1. Filleting

Muscles associated with the femur stretch across and articulate with the pelvis, sacrum, and tibia. When filleting the femur for drying meat and making sausage, muscles were removed individually. Thin sinuous membranes separate muscles. Initially, many ‘outer’ muscles were removed without impacting underlying bone. To separate individual muscles, the butcher made cuts along the sinuous membranes. After a small portion of two muscles was separated, the butcher inserted his fingers between the muscles to force them apart and to facilitate inserting the knife to cut the muscles free at their origins and insertions. The latter did not occur in any particular sequence. When filleting for drying meat, individual muscles retained their enclosing membranes, preventing flies from laying eggs in the meat while drying. During filleting the knife was constantly turned and rotated and was not used in one particular position, but was mostly used with the blade transverse to diagonal to the long axis of the bone. The knife was applied along the long axis of the bone in a shaving or slicing motion. The knife blade was sometimes perpendicular to the bone surface when filleting strokes reached the vicinity of the proximal femur, but cutting strokes were longitudinal as opposed to transverse. Therefore, these cut marks should be distinguishable from disarticulation cuts.

When removing muscles on the anterior side of the femur, transverse cuts were directed toward the distal shaft after which the blade was turned to a shallow angle with the bone surface and muscles were shaved or sliced free from the underlying bone from distal to proximal. The proximal femur on the anterior side in the vicinity of the epiphysis was sometimes impacted by this activity. Moreover, both proximal and distal epiphyses were cut during filleting because some muscles originate and/or insert at these locations. On both the
medial and lateral surfaces of the femur, shaving and slicing actions with the knife held transverse to diagonal, but moved along the long axis of the bone, were used to remove muscles. Video footage shows that the knife sometimes impacted the proximal and distal epiphyses during filleting and resulted in cut marks associated with defleshing located at epiphyses. Cut marks associated with filleting are presented in Figures 4.170 and 4.171. Cut marks produced by either filleting or disarticulation are depicted in Figure 4.172. Table 4.27 shows that the majority of filleting marks are located on the distal shaft with fewer cuts on the mid and proximal shaft and a few cuts on the proximal and distal epiphyses.

4.4.7.1.2. Disarticulating the femur from the pelvis

A full description of this activity is given above in section 4.4.6.1.3. Cut marks associated with this activity are presented in Figure 4.173. Figure 4.172 displays cut marks that were produced by either disarticulation or filleting. Table 4.27 indicates that only one disarticulation mark occurs on the proximal epiphysis.

4.4.7.1.3. Disarticulating the femur from the tibia

Before making any cuts the butcher located the joint by hand. The tibia was held in the left hand while transverse cuts relative to the long axis of the joint were made to the anterior surface of the articulation in the vicinity of the patella. These cuts were extended to the lateral surface of the joint. The knife was held perpendicular to the joint, but not necessarily to the bone surfaces. The articulation is rather loose and few cuts were required to cut through meat and connective tissues before the elements were disarticulated. Figure 4.173(b) and (c) shows cut marks associated with disarticulation. Table 4.27 shows that all cut marks produced when disarticulating the femur from the tibia are located on the distal epiphysis.
Table 4.27. Frequency distribution of cut marks on small bovid femora. F = filleting, FD = filleting and disarticulation, D = disarticulation, PE = proximal epiphysis, PS = proximal shaft, MS = mid shaft, DS = distal shaft, DE = distal epiphysis.

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4.4.7.2. Large Bovids

Butchery activities observed while processing the femur include filleting, disarticulating the femur from the pelvis, and disarticulating the femur from the tibia. The latter two activities were not normally carried out when the animal was processed for drying meat and for making sausage. Filleting normally occurred while elements were articulated. Figures 4.174 and 4.175 display cut marks produced by all butchery activities.

4.4.7.2.1. Filleting

This activity was very similar to that described above for small bovids in section 4.4.7.1.1 except that many more cutting strokes were applied for large bovids and the task took considerably more time to complete. The knife was constantly turned and cuts were made from both the proximal and distal ends. Cut mark types produced during filleting include shave/cuts, shaves, slices, and cuts. Very few puncture marks were recorded. Video footage shows that epiphyses as well as articular surfaces at both the proximal and distal ends were impacted during filleting. Cutting actions were predominantly diagonal to longitudinal to the long axis of the bone with the cutting edge held at a shallow angle with the bone.
surface. However, at the anterior, medial, and lateral surfaces of the distal shaft, cutting actions were in some cases transverse to diagonal to the long axis of the bone and sometimes the cutting edge was held perpendicular to the bone surface. Nevertheless, these cuts are clearly distinguishable from disarticulation marks in that they are a considerable distance from the distal articular surfaces. Figures 4.176 and 4.177 show cut marks produced by filleting while Figures 4.178 and 4.179 display cut marks produced by either filleting or disarticulation. There is clear overlap in the location of cut marks produced by these two activities and at the proximal epiphysis these marks can not be attributed to one or the other activity and therefore remain ambiguous. However, cut marks at the distal epiphysis and articular surfaces can in some cases be attributed to a single activity.

As mentioned above and described in the disarticulation section, cutting actions associated with filleting are mostly made with the cutting edge of the tool at an angle with the bone surface. Therefore, cut marks at the distal epiphysis and articular surfaces made during filleting tend to be shave/cuts and shaves, while cut marks at these locations produced by disarticulation are more commonly cut and slice marks. Based on orientation and angulation, it is therefore possible to attribute single butchery activities to certain marks at these locations. However, since articular surfaces are not always perpendicular to disarticulation cutting activities, shave/cuts and shaves are sometimes produced on articular surfaces during disarticulation. Therefore, certain marks at the distal epiphysis and articular surfaces will remain ambiguous. Table 4.28 shows that cut marks produced by filleting alone are most numerous on the shaft portions of the femur with significantly fewer marks at the epiphyses. Nevertheless, filleting marks do occur at epiphyses. When cut marks were attributed to disarticulation only, they are located exclusively at the epiphyses. Disarticulation cuts are more numerous at the proximal epiphysis as the joint between the femur and pelvis is tighter and more difficult to disarticulate than the joint between the femur and tibia.

4.4.7.2.2. Disarticulating the femur from the pelvis

This activity is described above in section 4.4.6.2.3. Cut marks are mostly transverse to diagonal with respect to the long axis of the element. Cut marks are restricted to the trochanter major, head, fovea capitis, and neck (Figures 4.180 and 4.181(a) and (d)). As can be seen in the filleting, and filleting and disarticulation figures, there is significant overlap in the anatomical placement of marks produced by these activities and those produced by
disarticulation. This is particularly evident at the trochanter major and neck yet several non-
disarticulating marks occur on the head as well. During disarticulation, more marks are
produced on the head than during other activities. Cut marks at the fovea capitis were only
produced by disarticulation. Therefore, cut marks at the fovea capitis are unambiguously
attributed to disarticulation. This statement is supported by the fact that unlike the trochanter
major, neck, and head, the fovea capitis is never exposed to the butchery tool during filleting.
In contrast, since the accessory and round ligaments - which bind the femur to the acetabulum
- are attached at the fovea capitis, the latter is highly likely to be impacted by the butchery
tool when these ligaments are severed to disarticulate the femur from the pelvis. Table 4.28
shows that all disarticulation marks are located at the proximal epiphysis, none occur on the
proximal shaft. Marks produced by filleting and/or disarticulation occur in similar
proportions at the proximal epiphysis and proximal shaft. While filleting marks do occur at
the proximal epiphysis, they are more common and fairly evenly distributed at the proximal,
mid and distal shaft (Table 4.28).

4.4.7.2.3. Disarticulating the femur from the tibia

As mentioned above, this activity was not normally carried out since it does not facilitate
filleting. This activity was performed after the rear limb was disarticulated from the axial
skeleton. The limb was held with the knee joint facing up by one butcher while a second
made transverse cuts relative to the long axis of the joint to the anterior surface towards the
articulation between the distal femur and proximal tibia. These cuts were extended to the
medial and lateral surfaces. The meat was cleaved down to the articular area from the medial
and lateral sides. Transverse cuts were then made between the articular surfaces of the distal
femur and proximal tibia on the anterior, medial, and lateral sides of the joint. The limb was
then stood on the pelvis with the distal tibia facing up. The tibia was pulled caudally, flexing
the joint, thereby stretching the ligaments and connective tissues and exposing the articular
surfaces. Transverse cuts relative to the long axis of the joint were then made to both the
medial and lateral sides of the joint. These cuts were made in the vicinity of the articular
condyles of the distal femur. These cuts were further extended to cross the medial, anterior,
and lateral surfaces of the joint.

The limb was laid down and transverse cuts were made across the lateral surface of the
limb from the posterior to anterior edge. These cuts cleaved the meat at the posterior edge,
while cuts at the anterior edge penetrated between the articular surfaces of the distal femur and proximal tibia. Additional cuts were made on the lateral surface towards the knee joint, cleaving the meat and exposing the joint. The limb was then turned and transverse cuts were made through meat and toward articular surfaces on the posterior side. The limb was then turned to stand on its anterior end and transverse cuts were made to the posterior surface through meat and toward the posterior surfaces of the knee joint. The limb was laid down again and further transverse cuts were made to the medial surfaces of the articulation between the distal femur and proximal tibia. These cuts were made into ligaments and connective tissues binding the knee joint. These cuts were made between the articular surfaces of the joint, towards the tubercles of the spine on the proximal tibia. The tibia was then pushed down laterally to expose ligaments and connective tissues, which were cut to separate the femur from the tibia. Figures 4.180 and 4.181 display cut marks produced by these activities. All disarticulation marks are located on the distal epiphysis, particularly on the lateral surface and the trochlea. Figures 4.178 and 4.179 display cut marks that were produced by either disarticulation or filleting. Table 4.28 shows that all cut marks associated with disarticulating the femur from the tibia are located on the distal epiphysis.

4.4.7.2.4. Sawing the femur from the tibia

This activity was carried out on one specimen. The tibia was sawn from the femur with meat attached to prepare the former for stewing. After the tibia was severed from the femur it was sawn into cubes. The latter were not retained after butchery observations. The location of saw marks are depicted in Figure 4.182 and Table 4.28 shows that both saw marks occur at the distal epiphysis.
Table 4.28. Frequency distribution of cut marks on large bovid femora. F = filleting, FD = filleting and disarticulation, D = disarticulation, PE = proximal epiphysis, PS = proximal shaft, MS = mid shaft, DS = distal shaft, DE = distal epiphysis.

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4.4.8. TIBIA

4.4.8.1. Small Bovids

Butchery activities associated with the tibia include disarticulating the tibia from the metatarsal, filleting, and disarticulating the tibia from the femur. The rear limb was normally filleted in an articulated state since disarticulation does not facilitate filleting. Cut marks produced by all butchery activities are presented in Figures 4.183 and 4.184.

4.4.8.1.1. Disarticulating the tibia from the metatarsal

A full description of this activity is given below in section 4.4.10.1.1. Examination of video footage shows that disarticulation actions were applied directly to the tarsal bones. Although the cut mark displayed in Figure 4.186 could have been produced by either disarticulation or filleting, video footage shows that this cut resulted from filleting. No disarticulation cut marks were produced on distal tibiae.
4.4.8.1.2. Skinning

For more detail on skinning, see section 4.2.2. After the skin was pierced at the tarsal bones, incisions were made from the tarsals to the crotch along the medial surface of the limb. When a metal blade was used it was normally held upside down whereas a stone tool was used with the cutting edge facing the bone. Since the tibia is covered with a considerable amount of soft tissues, no cut marks were produced by this activity.

4.4.8.1.3. Filleting

Meat and soft tissues at the proximal epiphyses, distal shaft, and distal epiphyses of tibiae are very sinuous. In my study, meat from tibiae was either used for making sausage or for stewing. The meat is too sinuous for making biltong. Consumers informed me that unless meat was removed for making sausage, these elements were normally sawn into chunks and boiled. Through boiling, the meat and sinuous tissues become tender. Procedures for filleting small bovid tibiae were roughly the same as those employed for large bovids as described below in section 4.4.8.2.3. The most significant difference was that small bovids required considerably fewer cutting strokes and were filleted more swiftly than large bovids. Most cutting actions were longitudinal to diagonal to the long axis of the bone although a few transverse cutting strokes were applied at mid shaft on the posterior surface of the tibia. The latter cuts were made to sever the distal extremities or tendons of muscles on the back of the distal limb. Cut mark types produced during filleting include shave/cuts, shaves, cuts, and slices. No puncture marks were recorded. Filleting marks are displayed in Figure 4.185 while Figures 4.186 and 4.187 depict cuts produced by either filleting or disarticulation. However, having reviewed the butchery footage it is clear that the cut mark in Figure 4.186(c) is the result of filleting. Table 4.29 shows that the majority of cut marks are located on the mid shaft, followed by the proximal shaft. Very few cuts are on the distal shaft. No filleting marks were recorded at either the proximal or distal epiphyses.

4.4.8.1.4. Disarticulating the tibia from the femur

This activity is described above in section 4.4.7.1.3. Cut marks on the articular surface of the proximal tibia presented in Figure 4.187 were produced by disarticulation. Video footage shows that the blade of the butchery tool never penetrated between the articular surfaces of
the distal femur and proximal tibia. Table 4.29 shows that disarticulation marks occur only on the proximal epiphysis.

Table 4.29. Frequency distribution of cut marks on small bovid tibiae. F = filleting, FD = filleting and disarticulation, PE = proximal epiphysis, PS = proximal shaft, MS = mid shaft, DS = distal shaft, DE = distal epiphysis.

<table>
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<td>0</td>
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4.4.8.2. Large Bovids

Butchery activities observed during the processing of tibiae include disarticulation from metatarsals, skinning, filleting, disarticulating tibiae from femora, and sawing and filleting. Figures 4.188 and 4.189 display cut marks produced by all butchery activities.

4.4.8.2.1. Disarticulating the tibia from the metatarsal

This procedure is described below in section 4.4.10.2.1. No disarticulation cutting actions were observed to impact the tibia and therefore no cut marks could be unambiguously assigned to this activity.

4.4.8.2.2. Skinning

Procedures employed were the same as those described for small bovids in section 4.4.8.1.2, but more cutting strokes were employed while skinning large bovids. An alternative
method was observed where skinning was initiated at the distal tibia with circular cuts made transverse to the long axis of the bone and around the entire circumference of the distal tibia. After the skin was pierced it was freed in the same manner as that described above for small bovids. Transverse cut marks at the distal tibia were also produced during filleting and therefore attributing marks to a single activity was not possible. However, skinning actions were made perpendicular to the bone surface whereas filleting marks were normally made at an angle with the bone surface. Therefore, the angulation of marks may indicate the activity that produced them. Certain transverse cut marks at the distal shaft and epiphysis in Figure 4.192 may be the result of skinning. Similarly, some of the SFD marks at the distal shaft and epiphysis in Table 4.30 are the result of skinning.

4.4.8.2.3. Filleting

Meat on the tibia is very sinuous, and in my experience this meat was never used for drying or for roasting, but rather boiled in stews or used for making sausage. I have not seen this observation noted by other scholars in ethnographic contexts. The process of boiling softened the meat, making it more palatable. Longitudinal cuts relative to the long axis of the bone were made along the posterior and medial surfaces of the element with the cutting edge held at a shallow angle with the bone surface. These cuts were made from distal to proximal and extended across the articulation between the proximal tibia and distal femur. The bone was then rolled over and similar longitudinal cuts were made at the proximal end of the tibia on the posterior surface with the cutting edge at a relatively shallow angle with the bone surface. From video footage it is clear that these filleting actions impacted both the distal femur and proximal tibia. The distal articular condyles of the femur were exposed to cutting actions as the cutting tool slipped from the proximal tibia and impacted the distal femur. Tendons at the distal extremity of muscles attached to the distal shaft of the tibia were severed by diagonal to transverse cuts with the cutting edge more or less perpendicular to the bone surface. To accomplish the latter task the cutting tool was sometimes used upside down, and cutting motions were made away from the bone after the knife was inserted between tendons and underlying bone.

The limb was turned again and work proceeded on the lateral surface. Tendons inserting on the tuber calcis were severed with transverse cuts directly through them. No bone was impacted during the latter activity. Longitudinal cuts relative to the long axis of the bone
were then made at the distal shaft to sever tendons inserting at the distal tibia. Additional longitudinal cuts were made from distal to proximal while the muscles were ‘rolled’ from the bone. A great deal of cutting took place at the proximal tibia as numerous strong tendons and ligaments are located there. The knife was often turned around at this locality. Video footage reveals that the proximal epiphyses of the tibia, distal epiphyses of the femur, as well as patellae were exposed to these cutting actions. The soft tissues below the patellae include a considerable amount of fat. A great deal of cutting was applied at the proximal epiphysis of the tibia to remove all soft tissues. Additional longitudinal cuts relative to the long axis of the bone were made along the lateral and anterior surfaces of the tibia shaft with the cutting edge held at an angle with the bone surface.

The limb was rolled again and further cuts were applied to the posterior surface of the proximal shaft. These longitudinal cuts were then extended from proximal to distal along the posterior surface of the shaft. Remaining tendons were severed at the distal shaft, freeing the bone of all meat. Cut mark types consist predominantly of shaves and shave/cuts, but several cuts and slices were also recorded. The majority of cut marks are located on the posterior surface of the tibia shaft. Unexpectedly, few cut marks are located at the proximal epiphysis. Cut marks produced by filleting are displayed in Figures 4.190 and 4.191. Cut marks produced by either skinning, filleting, or disarticulation are depicted in Figures 4.192 and 4.193. As mentioned in the skinning section above, some marks at the distal epiphysis could have been produced when skinning was initiated at the distal tibia as opposed to the tarsals. Although there is some overlap with the location of disarticulation marks, certain cut marks at the proximal epiphysis are undoubtedly associated with filleting, particularly when cuts are not perpendicular to bone surfaces. Therefore, shave/cuts and shaves at the proximal epiphysis in Figures 4.192 and 4.193 are more likely the result of filleting than disarticulation. However, when angulation of cuts can not be determined, cuts at this location remain ambiguous and can not be attributed to a single activity. Table 4.30 shows that the majority of filleting marks are located on the shaft, particularly the mid and proximal shaft. Filleting marks do occur at the proximal epiphysis, but cut marks at the distal epiphysis are ambiguous and can not be attributed to a single activity. Bear in mind that certain cuts in the SFD category of Table 4.30 are filleting marks.
4.4.8.2.4. Disarticulating the tibia from the femur

This activity is described above in section 4.4.7.2.3. Most disarticulation marks are located on the proximal articular surfaces of the tibia (Figures 4.194 and 4.195(a)). Since the joint is relatively loose and easy to locate, cuts were made directly to and between articular surfaces. Most cutting actions were made directly into hyaline cartilage. Some overlap in the anatomical location of cut marks produced by filleting and disarticulation was observed (Figures 4.192 and 4.193(a)). Nevertheless, cut marks that impact articular surfaces are more likely the result of disarticulation since filleting actions were not observed to penetrate between the articular surfaces of the distal femur and proximal tibia. It is possible that cut marks on the anterior tuberosity in Figure 4.193(a) were produced by filleting and therefore cut marks at this locality can not be attributed to a single activity. Cut marks that undoubtedly result from disarticulation are those on the medial and lateral edges of the tubercles of the spine as depicted in Figure 4.195(a). These marks result from severing the anterior cruciate ligament, which binds the tibia to the femur. Table 4.30 shows that all disarticulation marks occur at the proximal epiphysis.

4.4.8.2.5. Sawing

Two specimens were processed in this manner. The tibia was sawn proximally from the femur and distally from the metatarsal. The shaft was then sawn into cubes in preparation for stewing. The shaft bones were not retained after butchery observations. Figure 4.196 and Table 4.30 show the locations of saw marks. All saw marks are transverse to the long axis of the tibia.
Table 4.30. Frequency distribution of cut marks on large bovid tibiae. F = filleting, SFD = skinning, filleting, and disarticulation, D = disarticulation, SA = sawing, PE = proximal epiphysis, PS = proximal shaft, MS = mid shaft, DS = distal shaft, DE = distal epiphysis.

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<th>MS</th>
<th>DS</th>
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<th>Total</th>
</tr>
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</tr>
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</tr>
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</tr>
</tbody>
</table>

4.4.9. PATELLA

4.4.9.1. Small Bovids

Both filleting and disarticulation may be associated with patellae. Normally the rear limb was processed with elements articulated, but in one case I requested disarticulation of the femur from the tibia.

4.4.9.1.1. Filleting

No meat that can be used for making biltong or sausage is associated with the patella, and filleting this element was never observed. Filleting the rear limb ended both at the distal femur and proximal tibia. Therefore no filleting marks were produced on patellae.
4.4.9.1.2. Disarticulating the femur from the tibia

See section 4.4.7.1.3 above for a description of this activity. Transverse cuts were made above the patella after the butcher located the joint by hand. The patella remained attached to the proximal tibia. The patella was not cut marked by this activity.

4.4.9.2. Large Bovids

Butchery activities, which were observed to impact patellae, include filleting and disarticulation. Cut marks produced by all butchery activities are presented in Figure 4.197.

4.4.9.2.1. Filleting

Since muscles extend from the distal femur to the tibia, patellae were sometimes cut during filleting. As cutting strokes were normally applied with the cutting edge at an angle with the bone surface, the majority of cut marks are shave/cuts although a few slices and cuts were recorded. All marks in Figure 4.197 except the one replicated in Figure 4.198 were produced by filleting. Table 4.31 presents the number of cut marks associated with this activity.

4.4.9.2.2. Disarticulating the femur from the tibia

This activity is described above in section 4.4.7.2.3. Since the patella is easy to locate by hand, it is unlikely that cut marks often impact this bone during disarticulation. Moreover, cutting against the patellae does not facilitate disarticulation. This is evidenced by the single mark displayed in Figure 4.198. Moreover, this mark was produced by either filleting or disarticulation and can not be attributed to a single activity. Given the above, it is more likely that cut marks on patellae result from filleting than disarticulation. Table 4.31 shows that only one cut mark was attributed to filleting and disarticulation.
Table 4.31. Frequency distribution of cut marks on large bovid patellae. F = filleting, FD = filleting and disarticulation, EP = epiphysis.

<table>
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<td>21</td>
</tr>
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<td>1</td>
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<td>F</td>
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<td>100%</td>
<td></td>
</tr>
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4.4.10. TARSALS

4.4.10.1. Small Bovids

Activities observed for the butchery of tarsals include disarticulating metatarsals from tibiae, skinning, and filleting. Figure 4.199 shows cut marks produced by all butchery activities.

4.4.10.1.1. Disarticulating the tibia from the metatarsal

The butcher first located the joint by hand before making any cuts. With the metatarsal held in the left hand and the knife held transverse to the long axis of the metatarsal, cuts were made directly to the tarsal bones. The blade of the knife was used perpendicular to the bone surface. Cuts were initially made to the anterior surfaces of the tarsals and then extended to the medial surface, back to the anterior surface and extended again to the lateral surfaces. The metatarsal, with some tarsals attached to it, was snapped caudally (towards the rear) and twisted sideways. The latter action exposed connective tissues that were then cut to free the metatarsal along with some tarsals from the tibia. The tibia also retained some tarsals. Figures 4.200 and 4.201 depict cut marks produced during disarticulation. As expected from the butchery actions described above, very few cut marks are present on the posterior surfaces of the tarsals. Figure 4.202 shows cut marks that were produced by either disarticulation or
skinning. Table 4.32 indicates that the vast majority of disarticulation marks are located on the astragalus while fewer marks occur on the calcaneum and naviculo-cuboid. Disarticulation marks account for at least 90% of cut marks on tarsals.

4.4.10.1.2. Skinning

During disarticulation the skin was pierced, and disarticulation cuts may therefore be seen to double as initial cuts for skinning. While lifting the skin away from the bone, the knife point was inserted from proximal to distal between the skin and underlying bone and/or soft tissues. The knife was inserted upside down on the medial side of the limb. This incision was extended to the crotch where it intersected the skinning incision running the length of the animal along the mid-line on the ventral surface. The skin was worked loose from the tarsals by making longitudinal, diagonal, to transverse cuts between the skin and underlying tissues. The skin was worked loose from medial to lateral and from distal to proximal. The left hand pulled the skin free while cuts were made with the right hand. Cuts were most commonly made against the skin, but on some occasions contact with bone was unavoidable, particularly where very thin layers of soft tissue cover the bone surface and where the skin was difficult to free. Figure 4.203 displays the location of skinning and filleting marks, while Figures 4.202 and 4.204 show cut marks that were produced by either skinning, disarticulation, filleting, or hanging the carcass. Table 4.32 indicates that skinning marks are most common on the tuber calcis. Unambiguous skinning marks include shave/cut and shave marks.

4.4.10.1.3. Filleting

Only the tendons attached to the tuber calcis are associated with meat. These tendons were severed mostly by shaving actions. Figure 4.204(b) shows the location of a cut mark which is either associated with filleting or hanging the carcass. Because the skin is taut between the proximal end of the tuber calcis and the distal tibia, I am confident that this shave mark is not associated with skinning, but is the result of freeing a tendon. Table 4.32 shows that the only filleting mark occurs on the olecranon. There are 16 sets or 52 tarsal bones included in the analysis. In Table 4.32 I use 16 as the MNE.
Table 4.32. Frequency distribution of cut marks on small bovid tarsals. D = disarticulation, SF = skinning and filleting, SD = skinning and disarticulation, S = skinning, AS = astragalus, CA = calcaneum, NC = naviculo-cuboid, TC = tuber calcis, LM = lateral malleolus.

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4.4.10.2. Large Bovids

Butchery activities associated with processing tarsals include disarticulation, skinning, and filleting. Figure 4.205 displays cut marks produced by all butchery activities.

4.4.10.2.1. Disarticulating the tibia from the metatarsal

The metatarsal was held in the butcher’s left hand while an assistant supported the proximal part of the limb. Transverse cuts relative to the long axis of the joint were made on the anterior surface directly towards the joint with the cutting edge held more or less perpendicular to non-articular bone surfaces. These cuts were then extended across the medial surfaces of the tarsal bones. The knife point was sometimes inserted between the tarsal bones from anterior to posterior and levered back and forth to sever connective tissues. Transverse cuts were also extended to the lateral surfaces of the tarsals. Very few transverse cuts were made to the posterior surfaces. Numerous cuts were repeated across the anterior,
medial and lateral surfaces, but as stated above, considerably fewer cuts were made to the posterior surfaces. After connective tissues were severed the metatarsal was snapped caudally (backwards), away from the cuts made to the anterior surfaces of the joint. This action tore, stretched, and exposed additional connective tissues that were then cut transversely from anterior to posterior to free the metatarsal from the tibia. Most of the time the distal tibia retained the calcaneum, astragalus, and lateral malleolus, while the remainder of the tarsals adhered to the proximal metatarsal. Cut mark types include mostly cuts and slices, though a few shave/cuts and shaves were recorded. Cut marks produced by disarticulation are shown in Figures 4.206 and 4.207. Cut marks produced by either disarticulation, filleting or hanging the carcass are depicted in Figure 4.208. Video footage shows that cut marks displayed in the latter figure are more likely associated with filleting or hanging the carcass. Table 4.33 shows that the majority of marks are located on the naviculo-cuboid, with considerably fewer marks on the astragalus. Even fewer marks are located on the calcaneum, external, and middle cuneiform and very few marks were recorded on the internal cuneiform. No disarticulation marks occurred on the tuber calcis.

4.4.10.2.2. Skinning

The same procedures as those described above for small bovids in section 4.4.10.1.2 were employed. However, more cutting strokes were applied when skinning large bovids. Since the cutting edge was almost always at an angle with the bone surface, nearly all skinning marks are shave/cuts and shaves. Very few cuts and slices were recorded. Skinning and filleting marks are depicted in Figure 4.209. Cut marks resulting from either skinning, disarticulation, filleting, or hanging the carcass are depicted in Figures 4.208 and 4.210. Cut marks in Figures 4.208(c) and 4.210(c) are almost certainly the result of filleting or hanging the carcass, whereas the marks in Figures 4.208(d) and 4.210(d) can not be attributed to a single activity. Table 4.33 shows that the vast majority of skinning marks are located on the tuber calcis.

4.4.10.2.3. Filleting

The same procedures were employed as those described above for small bovids in section 4.4.10.1.3. No meat is associated with the tarsal bones, except the insertion of certain muscle tendons on the tuber calcis. No cut marks on the tarsal bones were unambiguously
attributed to filleting. There are 18 sets or 80 tarsal bones included in the analysis. In Table 4.33 I use 18 as the MNE.

Table 4.33. Frequency distribution of cut marks on large bovid tarsals. D = disarticulation, SF = skinning and filleting, SD = skinning and disarticulation, S = skinning, AS = astragalus, CA = calcaneum, NC = naviculo-cuboid, TC = tuber calcis, C1 = external and middle cuneiform, C2 = internal cuneiform.

<table>
<thead>
<tr>
<th>Activity</th>
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</tr>
</thead>
<tbody>
<tr>
<td>AS</td>
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<tr>
<td>D (18)</td>
<td>77</td>
</tr>
<tr>
<td>SF (18)</td>
<td>0</td>
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<tr>
<td>SD (18)</td>
<td>0</td>
</tr>
<tr>
<td>S (18)</td>
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<td>Total</td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Activity</th>
<th>Portion</th>
</tr>
</thead>
<tbody>
<tr>
<td>AS</td>
<td>CA</td>
</tr>
<tr>
<td>D</td>
<td>22%</td>
</tr>
<tr>
<td>SF</td>
<td>0%</td>
</tr>
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<td>SD</td>
<td>0%</td>
</tr>
<tr>
<td>S</td>
<td>0%</td>
</tr>
<tr>
<td>Total</td>
<td>21%</td>
</tr>
</tbody>
</table>

4.4.11. RIBS

4.4.11.1. Small Bovids

Butchery activities observed while processing ribs include evisceration, the removal of flanks or belly sheets, filleting, and disarticulating ribs from thoracic vertebrae. Evisceration was always performed shortly after the animal was killed. The flanks were always removed before filleting or disarticulation. Normally the ribs were defleshed while still articulated with the thoracic vertebrae. In one case, at my request, ribs were disarticulated from the thoracic vertebrae. Only ribs with evisceration marks are included in the production of figures and tables since the activities associated with butchering the ribs is very repetitive. I am confident that the patterning of cut marks presented here is representative of the total sample. Figures 4.211 and 4.212 depict cut marks produced during all butchery activities.
4.4.11.1.1. Evisceration

The ribs are associated with the upper viscer a. A more detailed description of the initial stages of evisceration is given above in section 4.2.1. In some cases, before any cuts were made to free the upper viscer a from the abdominal cavity, the rib cage was opened to facilitate removal of the upper viscer a. This process is described in more detail above in section 4.2.1. Before loosening the upper viscer a from the abdominal cavity, the knife was used to cut through the diaphragm toward the medial surfaces of the rib shafts. The diaphragm extends from the proximal medial surface of the last rib to the distal medial surface of the 8th or 9th rib. After the diaphragm was severed, the organs of the upper viscer a were freed by making diagonal to longitudinal cuts relative to the long axis of the axial skeleton from cranial to caudal - along the medial surfaces of the ribs – commonly near the distal end, middle and proximal rib shafts. After the upper viscer a were loosened from the ribs, thoracic and cervical vertebrae they were pulled free from the abdominal cavity in one piece.

Filleting and evisceration marks are distinct from each other for the following reasons. Filleting actions were made along the length of rib shafts on anterior, posterior and lateral surfaces with the cutting edge held at a shallow angle with the bone surface. In contrast, evisceration cuts were predominantly made across the shafts of ribs on the medial surfaces and with the cutting edge more or less perpendicular to the bone surface. Therefore, the orientation and angulation of cut marks at the locations where these two activities overlap can be used to separate them. When angulation of cut marks can not be determined where these activities overlap, marks can not be attributed to single activities. Importantly, no meat is associated with the medial surfaces of rib shafts and therefore cut marks at these locations are unambiguously associated with evisceration. Cut marks associated with evisceration are depicted in Figures 4.213 and 4.214. Cut marks that may be associated with either evisceration, filleting, or disarticulating ribs are presented in Figures 4.215 and 4.216. Table 4.34 shows that evisceration cut marks are most common on the distal rib shafts, followed by the mid and proximal shafts. Evisceration cuts are almost always on the medial surfaces of rib shafts, transverse to diagonal to the long axis of rib shafts and consist predominantly of slices, shave/cuts, and cuts.
4.4.11.1.2. *Removing the flanks or belly sheets*

The flanks were first loosened from the rear limbs by cutting between the posterior margin of the flank and the proximal medial surface of the rear limb. These cuts were extended to the proximal posterior margin of the last ribs. On reaching the posterior margin of the last ribs the knife was turned, and run along the posterior margin of the rib from proximal to distal. The knife was held at a very shallow angle with the bone surface and used in a shaving motion. The flanks were finally freed by a few longitudinal cuts in the vicinity of the last sternebrae. Cut marks produced during removal of the flanks are lumped as filleting marks and are included with filleting marks in the figures and tables.

4.4.11.1.3. *Filleting*

Since no meat is associated with the medial surfaces of ribs, filleting actions impact the posterior and anterior margins as well as the lateral surfaces of ribs. For more detail on removing the sirloins (which are attached to the proximal lateral surfaces of ribs) see sections 4.3.5.1.2 and 4.3.6.1.3.

The following section describes the removal of meat from ribs excluding the sirloin and tenderloin. For the most part, cuts were transverse to diagonal to the long axis of the axial skeleton or longitudinal to diagonal to the long axis of rib shafts. To remove intercostal meat a slicing and/or shaving action was used along the posterior and anterior margins of ribs with the knife pushed and/or pulled either ventrally or dorsally. These actions resulted mostly in shave/cuts, shaves, and nicks/notches. To remove meat from the lateral surfaces of ribs the butcher made diagonal to longitudinal cuts relative to the long axis of the rib shaft with the knife held at an acute angle with the bone surface. Cuts were made from dorsal to ventral and from ventral to dorsal. The most common marks produced by this activity are slices, shave/cuts and shaves. Figures 4.217 and 4.218 display cut marks produced during filleting. Figure 4.219 shows cut marks produced by either filleting or disarticulating the ribs. Table 4.34 shows that the majority of filleting marks occur on the proximal shaft with fewer marks on the mid and distal shaft and very few on the proximal epiphysis.
4.4.11.1.4. Disarticulating ribs from thoracic vertebrae

All actions were applied to the medial proximal ribs in the vicinity of the rib head, neck, and tubercle. Longitudinal cuts relative to the long axis of the axial skeleton were made directly to the articulation between the proximal ribs and the rib facets of the thoracic vertebrae working from the rear to the front of the animal. Since no meat adheres to the medial surfaces of ribs, and since viscera were always removed before butchery commenced, it was easy for the butcher to see the points of articulation and he could cut directly to the rib heads and rib facets on the thoracic vertebrae. The knife point was often inserted between the proximal rib and the thoracic vertebrae and levered back and forth to sever connective tissues. After some connective tissues were severed, the whole rib cage was forced laterally and dorsally, snapping the rib heads from the rib facets and exposing the articular surfaces and remaining connective tissues. The latter were then cut and the ribs freed from the thorax. Disarticulating the ribs is a time-consuming process and does not facilitate filleting. Figures 4.220 and 4.221 display cut marks associated with disarticulating the ribs. Table 4.34 indicates that the vast majority of disarticulation cuts are located at the proximal epiphysis.
Table 4.34. Frequency distribution of cut marks on small bovid ribs. F = filleting, E = evisceration, FDR = filleting and disarticulating ribs, DR = disarticulating ribs, FEDR = filleting, evisceration, disarticulating ribs, PE = proximal epiphysis, PS = proximal shaft, MS = mid shaft, DS = distal shaft.

<table>
<thead>
<tr>
<th>Activity</th>
<th>PE</th>
<th>PS</th>
<th>MS</th>
<th>DS</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>F (69)</td>
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<td>63</td>
<td>50</td>
<td>52</td>
<td>167</td>
</tr>
<tr>
<td>E (69)</td>
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<td>22</td>
<td>28</td>
<td>37</td>
<td>87</td>
</tr>
<tr>
<td>FDR (22)</td>
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<td>2</td>
<td>0</td>
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<td>5</td>
</tr>
<tr>
<td>DR (22)</td>
<td>50</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>50</td>
</tr>
<tr>
<td>FEDR (22)</td>
<td>0</td>
<td>8</td>
<td>0</td>
<td>0</td>
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<td>Total</td>
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<td>95</td>
<td>78</td>
<td>89</td>
<td>317</td>
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</table>

<table>
<thead>
<tr>
<th>Activity</th>
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<th>PS</th>
<th>MS</th>
<th>DS</th>
<th>Total</th>
</tr>
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<tr>
<td>F</td>
<td>1%</td>
<td>38%</td>
<td>30%</td>
<td>31%</td>
<td>100%</td>
</tr>
<tr>
<td>E</td>
<td>0%</td>
<td>25%</td>
<td>32%</td>
<td>43%</td>
<td>100%</td>
</tr>
<tr>
<td>FDR</td>
<td>60%</td>
<td>40%</td>
<td>0%</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td>DR</td>
<td>100%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td>FEDR</td>
<td>0%</td>
<td>100%</td>
<td>0%</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td>Total</td>
<td>17%</td>
<td>30%</td>
<td>25%</td>
<td>28%</td>
<td>100%</td>
</tr>
</tbody>
</table>

**4.4.11.2. Large Bovids**

Butchery activities associated with butchering the ribs include evisceration, removing the sirloins, disarticulating ribs from thoracic vertebrae, and filleting. Disarticulation is not necessary for filleting, but was carried out at both my request and under certain circumstances. Evisceration preceded other butchery activities but disarticulating the ribs and removing the sirloins may be carried out in any order. Therefore the order in which I describe these activities does not imply a butchery sequence. Only ribs with evisceration marks were used in the production of the figures and tables. This decision was taken because the patterning of cut marks was very repetitive. The patterning presented here is representative of the overall patterning of cut marks on ribs. Figures 4.222 and 4.223 depict cut marks produced by all butchery activities.
4.4.11.2.1. Evisceration

This procedure was the same as that described above for small bovids in section 4.4.11.1.1. Figures 4.224 and 4.225 display marks produced by evisceration while Figures 4.226 and 4.227 present cut marks produced by either evisceration, filleting, or disarticulating ribs. See section 4.4.11.1.1 for a description on distinguishing between evisceration and filleting marks. Table 4.35 shows that almost 50% of evisceration marks are on distal rib shafts and the remainder are on the mid and proximal shaft.

4.4.11.2.2. Removing the sirloins

This activity is also described above in sections 4.3.5.2.3 and 4.3.6.1.3. Two methods were observed for removing the sirloins. In the first scenario longitudinal cuts were made on either side of the vertebral dorsal spines from the base of the back in the vicinity of the sacrum to the base of the neck or last few cervical vertebrae. The muscles were then worked loose with longitudinal to diagonal cuts relative to the long axis of the axial skeleton, impacting the proximal lateral surfaces of rib shafts as well as the dorsal surfaces of lumbar transverse processes. In the second scenario the sirloins were loosened from the dorsal spines in the same manner as described above. However, the muscles were then worked from the proximal ribs by making cuts underneath the ventral surfaces of the sirloin in the vicinity of the lateral proximal surfaces of rib shafts. In this case, the knife was wedged between meat and bone and it is anticipated that fewer marks would have been produced by this activity. In both cases the sirloins were removed from the rear to the front. Cut marks associated with this activity include cuts, slices, shave/cuts, and shaves. Cut marks produced during sirloin removal are restricted to the proximal epiphysis and proximal shaft of ribs since the sirloins only extend a short way down the lateral rib shafts. Cut marks produced by sirloin removal are displayed in Figures 4.228 and 4.229. Certain cut marks in Figures 4.230 and 4.231 were produced by this activity. The PE and PS categories in Table 4.35 are applicable and show that the vast majority of marks are located on the proximal shaft with significantly fewer marks at the proximal epiphysis.

4.4.11.2.3. Disarticulating ribs from thoracic vertebrae

The procedures employed were more or less the same as those described above for small bovids in section 4.4.11.1.4. Longitudinal cuts relative to the long axis of the axial skeleton
were made directly to the articulation between the proximal ribs and thoracic vertebrae. After a series of these cuts were made along the entire rib slab, the two rib slabs were forced apart and the ribs snapped free from the thoracic vertebrae. In some cases the rib heads snapped off in the vicinity of the angle of the rib. The remaining connective tissues and flesh were then cut to separate ribs from thoracic vertebrae. Considerable force was used to snap the ribs from the vertebrae and in some cases three men were required to complete the task. Cut marks associated with disarticulating the ribs are presented in Figures 4.232 and 4.233. As expected from the above descriptions, Table 4.35 shows that the vast majority of disarticulation cuts are located on the proximal epiphysis with few cut marks on the proximal shaft.

4.4.11.2.4. **Sawing**

In a few cases the rib cages were sawn from the vertebral column. This activity was carried out when I had no control over butchery procedures and was performed to make large carcasses more manageable and to facilitate filleting. The ribs were sawn through immediately below the ventral extent of the sirloins. Figures 4.234 4.235 show saw marks. Table 4.35 shows that almost all saw marks are located at the proximal shaft with very few marks on the mid shaft.

4.4.11.2.5. **Filleting**

Procedures employed for filleting large bovid ribs were roughly the same as those described above for small bovids in section 4.4.11.1.3. However, significantly more cutting strokes were employed for large bovids and the process was much more time-consuming. The knife was often turned and cuts were made from various directions and angles. Cut mark types include cuts, slices, shaves, and shave/cuts. Filleting cuts are presented in Figures 4.228 and 4.229. Cut marks produced by either filleting or disarticulation are depicted in Figures 4.230 and 4.231. Table 4.35 shows that filleting marks are most common on the proximal shaft, followed by the mid and distal shaft. Significantly fewer marks are located at the proximal epiphysis. Marks at the latter location are ambiguous and may result from either filleting or disarticulation. However, if an assemblage is encountered where rib facets on thoracic vertebrae do not display cut marks, it is more likely that filleting produced cut marks on the proximal epiphyses of ribs.
Table 4.35. Frequency distribution of cut marks on large bovid ribs. F = filleting, SAF = sawing and filleting, E = evisceration, FDR = filleting and disarticulating ribs, DR = disarticulating ribs, FEDR = filleting, evisceration and disarticulating ribs, PE = proximal epiphysis, PS = proximal shaft, MS = mid shaft, DS = distal shaft.

![Table](image)

4.5. GENERAL OBSERVATIONS

Below I briefly discuss a few general observations made during this study which are directly relevant to current issues in butchery studies and to research concerning the dietary behaviour of humans and hominids. Here I briefly summarize these observations and then point the reader to where certain issues are discussed in more detail.

4.5.1. Butchered bones and the frequency of butchery-marked bones

As Lyman (1992, 1994b) has pointed out, for any meaningful analysis and interpretation of cut mark frequencies to proceed, it must be assumed that a direct and positive relationship exists between the number of bones that are butchered and the number of bones retaining...
butchery marks. Observations from this actualistic study are appropriate for investigating the nature of the relationship between butchered and cut marked bones since the numbers of butchered bones is known and all bones were examined microscopically for cut marks. A regression statistic reveals a very strong correlation \( (r^2 = 0.998) \) between butchered bones and the frequency of butchery-marked bones (Table 4.36). This issue is discussed in more detail in section 6.2.

Table 4.36. Results of regression between the number of butchered bones and the number of butchery-marked bones. The regression was performed using Microsoft Excel 97.

<table>
<thead>
<tr>
<th>Regression Statistics</th>
<th>Small bovids</th>
<th>Large bovids</th>
<th>Combined</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple R</td>
<td>0.994</td>
<td>0.999</td>
<td>0.999</td>
</tr>
<tr>
<td>R Square</td>
<td>0.988</td>
<td>0.999</td>
<td>0.998</td>
</tr>
<tr>
<td>Adjusted R Square</td>
<td>0.988</td>
<td>0.998</td>
<td>0.998</td>
</tr>
<tr>
<td>Standard Error</td>
<td>6.334</td>
<td>2.226</td>
<td>5.330</td>
</tr>
<tr>
<td>P – Value</td>
<td>0.80</td>
<td>0.19</td>
<td>0.95</td>
</tr>
<tr>
<td>Observations</td>
<td>18</td>
<td>18</td>
<td>18</td>
</tr>
</tbody>
</table>

Although a strong correlation exists between the number of butchered bones and the number of butchery marked bones for both small and large bovids, the frequencies of cut marks per butchered bone are significantly different between the two size groups for nearly all skeletal elements (see section 4.5.3).

**4.5.2. Anatomical placement of cut marks with unambiguous behavioural correlates**

A total of 16 933 cut marks are included in this study. Figures referred to earlier in this chapter show remarkable similarity in the overall anatomical placement of cut marks produced on small and large bovid skeletal elements. This indicates that certain tasks require cutting at specific anatomical locations regardless of animal size. However, frequencies of cut marks vary significantly between the two size groups as is described in more detail in section 4.5.3. In spite of that, I propose that the interpretation of cut marks based on their anatomical location, orientation, and angulation (type) can be applied to both small and large bovids. However, some variability was observed and the reader is urged to examine the above-mentioned figures carefully for subtle variations.
Table 4.37 presents 147 coded cut marks with unambiguous behavioural correlates. I was able to attribute single butchery activities to numerous cut marks because the majority (71%) of bones in this study were exclusively filleted. The quandary of dealing with butchery marked bones resulting from palimpsests of activities (e.g., Bartram 1993a; Binford 1978, 1981, 1984b, 1988; Bunn 1981; Gifford-Gonzalez 1989a; O'Connell et al. 1990, 1992) was not an issue in the MRM study. Quite plainly, elements that were exclusively filleted retained cut marks solely attributable to filleting. Since some bones (29%) were filleted and disarticulated, I was able to pick out specific marks that were never produced when bones were exclusively filleted, and attributed them to disarticulation.

In addition, butchery footage allowed me to review all butchery activities, and therefore I was able to observe cutting motions adopted, as well as anatomical locations affected by different butchery procedures. Different cutting actions created butchery marks of contrasting type, orientation, and angulation. For example, as described above (for instance see section 4.4.1.2.3) for certain butchery procedures, disarticulation required cutting across bone surfaces with the tool held transverse to the long axis of joints and with the cutting edge more or less perpendicular to bone surfaces. Disarticulation, therefore, commonly produced cuts and incisions. On the contrary, filleting required cutting along bone surfaces with the tool held longitudinally, diagonally, and occasionally transversely to the long axis of limbs or the axial skeleton and with the cutting edge at an angle with the bone surface. Filleting, therefore, commonly produced slices, shave/cuts, cut/shaves, and shaves or scrapes. Consequently, in many instances these peculiarities, as well as butchery footage, enabled me to assign cut marks to single activities based on orientation, angulation (type), and anatomical location.

The reader may observe that many cut marks can not be assigned to single butchery activities since disparate procedures do produce similar cut marks at identical anatomical locations. This issue is elaborated on in chapter 5, section 5.4 where I present a table including cut marks with ambiguous behavioural correlates.

Cut mark codes in Table 4.37 are based on Table 4.04 in Binford (1981: 136-141), but I include additional codes if he had none, or when my observations impelled me to assign behavioural correlates different from those presented by him. My initials (PJN) follow new codes. Where needed, I have modified Binford’s ‘part and description’ column to accommodate my data.

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8 See section 3.6 for description of cut mark types.
Figures 4.236 to 4.279 display the anatomical placement of cut marks produced by various butchery activities. These figures are based on my observations and data including cut marks on both small and large bovid bones. Cut marks on small and large bovid bones were lumped for reasons described above. Patellae are excluded as marks can be produced by either filleting or disarticulation. As mentioned earlier in section 4.1, metapodials and extremities are also excluded. In some cases, when disparate butchery activities produced similar marks at equivalent anatomical locations, cut marks were omitted from figures presented below. In other instances, based on careful examination of butchery footage as well as cut mark type, orientation, and angulation, cut marks were included where their behavioural correlates were not in doubt. A more detailed comparison between results from this study and those presented by Binford (1981) is made in chapter 5. For certain cut marks presented in Table 4.37, for example Hp-2 and RCp-2, my activity producing the mark differs from Binford’s. The reader may therefore reason that these marks are dubious with respect to attributing them to a single activity. I suggest the reader take into account that Binford’s behavioural correlates were based on butchery marked bones resulting from palimpsests of activities and in his own words “… the cut marks are still a consequence of several processing steps and distinguishing one from another a matter of inference” (Binford 1988: 134). As described above, my observations (particularly concerning filleting) are not compromised by the palimpsest dilemma and therefore I propose that my behavioural correlates are more reliable than Binford’s. In cases where cut mark codes are represented by very few cuts (e.g., code Hp-10 displayed in Figure 4.258 b, c) - even though similar marks were never produced by filleting - additional actualistic research is required to test or verify behavioural correlates attributed here.
Table 4.37. Inventory of butchery marks with unambiguous behavioural correlates. Code numbers are from Binford (1981, Table 4.04, pp. 136-141). My initials follow additional codes. Binford’s ‘part and description’ column was altered where required.

<table>
<thead>
<tr>
<th>Code Number</th>
<th>Part and Description</th>
<th>Binford's Activity</th>
<th>Nilssen's Activity</th>
<th>Binford's Figure Number</th>
<th>Nilssen's Figure Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-1</td>
<td>Skull transverse cuts on occipital condyles</td>
<td>dismembering</td>
<td>disarticulation</td>
<td>4.11</td>
<td>4.236 a, c</td>
</tr>
<tr>
<td>S-4</td>
<td>cuts at the base of horns longitudinal cuts on maxilla above the tooth row</td>
<td>skinning</td>
<td>skinning</td>
<td>4.10; 4.11</td>
<td>4.236 b, c</td>
</tr>
<tr>
<td>S-6</td>
<td>transverse cuts on paramastoid process diagonal and transverse cuts on nasal and maxilla</td>
<td>none</td>
<td>skinning</td>
<td>none</td>
<td>4.236 b; 4.237 a, b</td>
</tr>
<tr>
<td>S-8 (PJN)</td>
<td>diagonal and transverse cuts on lacrimal</td>
<td>none</td>
<td>skinning</td>
<td>none</td>
<td>4.236 b; 4.237 a, b</td>
</tr>
<tr>
<td>S-9 (PJN)</td>
<td>diagonal and transverse cuts on parietal</td>
<td>none</td>
<td>skinning</td>
<td>none</td>
<td>4.236 b</td>
</tr>
<tr>
<td>M-3</td>
<td>cuts on medial surface</td>
<td>dismembering</td>
<td>removing tongue</td>
<td>not shown</td>
<td>4.238 a</td>
</tr>
<tr>
<td>M-5</td>
<td>cuts on inferior surface of mandibular condyle</td>
<td>dismembering</td>
<td>disarticulating mandible from skull</td>
<td>not shown</td>
<td>4.238</td>
</tr>
<tr>
<td>M-7 (PJN)</td>
<td>cuts on medial surface of coronoid process</td>
<td>none</td>
<td>disarticulating mandible from skull</td>
<td>none</td>
<td>4.238 a</td>
</tr>
<tr>
<td>M-8 (PJN)</td>
<td>diagonal cuts on medial surface below mandibular notch</td>
<td>none</td>
<td>disarticulating mandible from skull</td>
<td>none</td>
<td>4.238 a</td>
</tr>
<tr>
<td>M-9 (PJN)</td>
<td>cuts on lateral surface of coronoid process</td>
<td>none</td>
<td>disarticulating mandible from skull</td>
<td>none</td>
<td>4.238 b</td>
</tr>
<tr>
<td>M-10 (PJN)</td>
<td>cuts on lateral surface of area surrounding mental foramen</td>
<td>none</td>
<td>skinning</td>
<td>none</td>
<td>4.238 b</td>
</tr>
<tr>
<td>M-11 (PJN)</td>
<td>cuts on lateral surface near ventral border on body and angle of mandible</td>
<td>none</td>
<td>skinning</td>
<td>none</td>
<td>4.238 b</td>
</tr>
<tr>
<td>CV-1</td>
<td>Cervical vertebrae transverse cuts across the anterior ventral surface of atlas</td>
<td>dismembering</td>
<td>disarticulating skull</td>
<td>4.20</td>
<td>4.239 b</td>
</tr>
<tr>
<td>CV-7 (PJN)</td>
<td>transverse cuts across the anterior dorsal surface of atlas</td>
<td>none</td>
<td>disarticulating skull</td>
<td>none</td>
<td>4.239 a</td>
</tr>
<tr>
<td>CV-8 (PJN)</td>
<td>cuts on cranial articular surface longitudinal and diagonal cuts on left, right, and dorsal surfaces</td>
<td>none</td>
<td>disarticulating skull</td>
<td>none</td>
<td>4.239 c</td>
</tr>
<tr>
<td>CV-9 (PJN)</td>
<td>transverse and diagonal cuts across cranial articular process</td>
<td>none</td>
<td>filleting</td>
<td>none</td>
<td>4.240 a; 4.241 a, b, c; 4.243 b, c, d</td>
</tr>
<tr>
<td>CV-11 (PJN)</td>
<td>transverse and diagonal cuts across caudal articular process</td>
<td>none</td>
<td>disarticulation</td>
<td>none</td>
<td>4.242 b</td>
</tr>
<tr>
<td>CV-12 (PJN)</td>
<td>transverse cuts on left and right borders of dorsal wing</td>
<td>none</td>
<td>disarticulation</td>
<td>none</td>
<td>4.242 c, d</td>
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<tr>
<td>CV-13 (PJN)</td>
<td>transverse and diagonal cuts on caudal surfaces</td>
<td>none</td>
<td>disarticulation</td>
<td>none</td>
<td>4.242 c, d</td>
</tr>
<tr>
<td>TV-2</td>
<td>Thoracic vertebrae longitudinal and diagonal cuts on both sides of dorsal spine</td>
<td>filleting</td>
<td>filleting sirloin</td>
<td>4.21</td>
<td>4.244 a, b, c; 4.245 a, b</td>
</tr>
<tr>
<td>TV-6 (PJN)</td>
<td>diagonal and transverse cuts on inferior surface of centrum</td>
<td>none</td>
<td>evisceration</td>
<td>none</td>
<td>4.244 a, b, d; 4.245 a, b, d</td>
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<tr>
<th>Code Number</th>
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<th>Nilssen's Activity</th>
<th>Binford's Figure Number</th>
<th>Nilssen's Figure Number</th>
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<tbody>
<tr>
<td>TV-7 (PJN)</td>
<td>longitudinal and diagonal cuts on dorsal and lateral surfaces of transverse processes and cranial articular processes</td>
<td>none</td>
<td>filleting sirloin</td>
<td>none</td>
<td>4.244 c; 4.245 a, c</td>
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<tr>
<td>TV-8 (PJN)</td>
<td>longitudinal cuts on medial side of articular surface of caudal articular process</td>
<td>none</td>
<td>filleting sirloin</td>
<td>none</td>
<td>4.245 b, c</td>
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<tr>
<td>TV-9 (PJN)</td>
<td>cuts on superior surfaces of centrum, ventral surfaces of articular and transverse processes, and rib facets</td>
<td>dismembering</td>
<td>disarticulating ribs</td>
<td>4.21</td>
<td>4.246; 4.247; 4.248; 4.249</td>
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</tbody>
</table>

Lumbar vertebrae

LV-1 (PJN) predominantly longitudinal and diagonal cuts on both sides of dorsal spine | none | filleting sirloin | none | 4.250 a, b |
LV-2 (PJN) longitudinal cuts on the dorsal surface, medial of the articular surfaces of the caudal articular process | none | filleting sirloin | none | 4.250 a, b, c |
LV-3 (PJN) longitudinal and diagonal cuts on dorsal and lateral surfaces of cranial articular process | none | filleting sirloin | none | 4.250 a, b, c |
LV-4 (PJN) predominantly longitudinal and diagonal cuts on dorsal surface of transverse process | none | filleting sirloin | none | 4.250 c |
LV-5 (PJN) longitudinal and diagonal cuts on middle and superior surfaces of centrum, mostly on cranial and caudal portions of centrum | none | filleting tenderloin | none | 4.250 a, b, d |
LV-6 (PJN) longitudinal and diagonal cuts on ventral surface of transverse process | none | filleting tenderloin | none | 4.250 d |
LV-7 (PJN) diagonal cuts on inferior surface of centrum | none | evisceration | none | 4.250 d |
LV-8 (PJN) transverse marks on dorsal, lateral, and ventral surfaces of cranial articular process | none | disarticulation | none | 4.251 |
LV-9 (PJN) transverse marks on dorsal, lateral, and ventral surfaces of caudal articular process | none | disarticulation | none | 4.251 |
LV-10 (PJN) transverse marks on lateral and ventral surface of centrum, on edge of articular surface | none | disarticulation | none | 4.251 b, d |

Sacrum

PS-11 (PJN) longitudinal and diagonal cuts on ventral surface | none | evisceration | none | 4.252 a |
PS-12 (PJN) longitudinal and diagonal cuts on ventral and cranial surfaces of sacrum wing | none | filleting tenderloin | none | 4.252 |
PS-13 (PJN) longitudinal and diagonal cuts on top, sides, and base of dorsal spine | none | filleting | none | 4.252 b; 4.253 |
PS-14 (PJN) diagonal and transverse cuts on and surrounding cranial articular process | none | disarticulating sacrum from lumbar vertebrae | none | 4.252; 4.253 |

(continued)
Table 4.37. (continued from previous page)

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<thead>
<tr>
<th>Code Number</th>
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<th>Binford's Figure Number</th>
<th>Nilssen's Figure Number</th>
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<tbody>
<tr>
<td>PS-15 (PJN)</td>
<td>marks on articular surface of sacro-iliac joint</td>
<td>none</td>
<td>disarticulating sacrum from pelvis</td>
<td>none</td>
<td>4.253</td>
</tr>
<tr>
<td><strong>Scapula</strong></td>
<td></td>
<td></td>
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<tr>
<td>S-3</td>
<td>longitudinal and diagonal marks along base of spine in both the supra- and infraspinous fossae</td>
<td>filleting</td>
<td>filleting</td>
<td>4.06</td>
<td>4.254 b</td>
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<tr>
<td>S-4</td>
<td>predominantly longitudinal and diagonal marks up and down the medial face of the scapula</td>
<td>filleting</td>
<td>filleting</td>
<td>not shown</td>
<td>4.254 d</td>
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<tr>
<td>S-5 (PJN)</td>
<td>longitudinal and diagonal marks on posterior and anterior surface of lateral spine</td>
<td>none</td>
<td>filleting</td>
<td>none</td>
<td>4.254 a, c</td>
</tr>
<tr>
<td>S-6 (PJN)</td>
<td>marks on posterior border</td>
<td>none</td>
<td>filleting</td>
<td>none</td>
<td>4.254 a</td>
</tr>
<tr>
<td>S-7 (PJN)</td>
<td>longitudinal and diagonal marks on neck and distal epiphysis</td>
<td>none</td>
<td>filleting</td>
<td>none</td>
<td>4.254</td>
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<tr>
<td>S-8 (PJN)</td>
<td>longitudinal to diagonal marks in groove posterior of tuber scapulae</td>
<td>none</td>
<td>filleting</td>
<td>none</td>
<td>4.254 d</td>
</tr>
<tr>
<td>S-9 (PJN)</td>
<td>multiple transverse cuts on posterior surface of neck and distal epiphysis</td>
<td>none</td>
<td>disarticulating scapula from humerus</td>
<td>none</td>
<td>4.255 a</td>
</tr>
<tr>
<td>S-11 (PJN)</td>
<td>cut mark on inferior surface of tuber scapulae</td>
<td>none</td>
<td>filleting</td>
<td>none</td>
<td>4.256</td>
</tr>
<tr>
<td>S-12 (PJN)</td>
<td>multiple transverse cuts on medial surface of neck</td>
<td>none</td>
<td>disarticulating scapula from humerus</td>
<td>none</td>
<td>4.255 d</td>
</tr>
<tr>
<td><strong>Humerus</strong></td>
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<tr>
<td>Hp-2</td>
<td>marks on the apex of the lateral tuberosity</td>
<td>dismembering</td>
<td>filleting</td>
<td>4.30</td>
<td>4.257 b, c</td>
</tr>
<tr>
<td>Hp-4</td>
<td>short “chevron” marks obliquely oriented along crest below the external tuberosity at insertion of teres minor</td>
<td>filleting</td>
<td>filleting</td>
<td>4.39</td>
<td>4.257 c</td>
</tr>
<tr>
<td>Hp-5</td>
<td>short “chevron” marks obliquely oriented on medial face below the head</td>
<td>filleting</td>
<td>filleting</td>
<td>4.39</td>
<td>4.257 a</td>
</tr>
<tr>
<td>Hp-6 (PJN)</td>
<td>transverse and diagonal cuts on medial tuberosity and superior articular surface of head</td>
<td>none</td>
<td>disarticulation</td>
<td>none</td>
<td>4.258 a</td>
</tr>
<tr>
<td>Hp-7 (PJN)</td>
<td>diagonal to longitudinal shave/cuts on medial tuberosity and edge of head</td>
<td>none</td>
<td>filleting</td>
<td>none</td>
<td>4.257 a</td>
</tr>
<tr>
<td>Hp-8 (PJN)</td>
<td>transverse to diagonal cuts on anterior surface of medial tuberosity</td>
<td>none</td>
<td>disarticulation</td>
<td>none</td>
<td>4.258 b</td>
</tr>
<tr>
<td>Hp-9 (PJN)</td>
<td>longitudinal cuts on anterior surface of medial tuberosity adjacent to head</td>
<td>none</td>
<td>filleting</td>
<td>none</td>
<td>4.257 b</td>
</tr>
<tr>
<td>Hp-10 (PJN)</td>
<td>diagonal mark below posterior edge of lateral tuberosity</td>
<td>none</td>
<td>disarticulation</td>
<td>none</td>
<td>4.258 b, c</td>
</tr>
<tr>
<td>Hp-11 (PJN)</td>
<td>marks on posterior surface of lateral tuberosity</td>
<td>none</td>
<td>filleting</td>
<td>none</td>
<td>4.257 d</td>
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<tr>
<td>Hp-12 (PJN)</td>
<td>transverse cuts on lower posterior surface of lateral tuberosity</td>
<td>none</td>
<td>disarticulation</td>
<td>none</td>
<td>4.258 d</td>
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<table>
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<tr>
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<th>Nilssen's Figure Number</th>
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<tbody>
<tr>
<td>Hp-13 (PJN)</td>
<td>transverse cuts on posterior surface of medial tuberosity adjacent to head</td>
<td>none</td>
<td>disarticulation</td>
<td>none</td>
<td>4.258 d</td>
</tr>
<tr>
<td>Hs-1 (PJN)</td>
<td>marks on all surfaces of the proximal, mid, and distal shaft</td>
<td>none</td>
<td>filleting</td>
<td>none</td>
<td>4.257</td>
</tr>
<tr>
<td>Hd-1</td>
<td>transverse cuts on distal articular surface of medial condyle</td>
<td>dismembering</td>
<td>disarticulation</td>
<td>4.30</td>
<td>4.258 b</td>
</tr>
<tr>
<td>Hd-4</td>
<td>diagonal and transverse cuts on lateral edge and articular surface of lateral condyle</td>
<td>dismembering</td>
<td>disarticulation</td>
<td>4.30</td>
<td>4.258 b, c</td>
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<tr>
<td>Hd-6</td>
<td>oblique short &quot;chevron&quot; marks clustered on neck of distal end on the anterior face</td>
<td>filleting</td>
<td>filleting</td>
<td>4.39</td>
<td>4.257 b</td>
</tr>
<tr>
<td>Hd-7</td>
<td>longitudinal marks along medial crest of shaft</td>
<td>filleting</td>
<td>filleting</td>
<td>4.39</td>
<td>4.257 a</td>
</tr>
<tr>
<td>Hd-8 (PJN)</td>
<td>diagonal cuts on medial epicondyle</td>
<td>none</td>
<td>filleting</td>
<td>none</td>
<td>4.257 a</td>
</tr>
<tr>
<td>Hd-9 (PJN)</td>
<td>diagonal shave/cuts on medial edge of medial condyle</td>
<td>none</td>
<td>filleting</td>
<td>none</td>
<td>4.257 b</td>
</tr>
<tr>
<td>Hd-10 (PJN)</td>
<td>longitudinal cuts on anterior articular surface of distal epiphysis, below coronoid fossa longitudinal to diagonal shave/cuts on edge and lateral surface of lateral condyle</td>
<td>none</td>
<td>filleting</td>
<td>none</td>
<td>4.257 b, c</td>
</tr>
<tr>
<td>Hd-11 (PJN)</td>
<td>longitudinal to diagonal marks on medial and lateral epicondyles</td>
<td>none</td>
<td>disarticulation</td>
<td>none</td>
<td>4.258 a, b</td>
</tr>
<tr>
<td>Hd-12 (PJN)</td>
<td>multiple diagonal cuts on articular and lateral surfaces of medial condyle</td>
<td>none</td>
<td>disarticulation</td>
<td>none</td>
<td>4.258 b</td>
</tr>
<tr>
<td>Hd-14 (PJN)</td>
<td>transverse marks on anterior articular surface of distal epiphysis, below coronoid fossa</td>
<td>none</td>
<td>disarticulation</td>
<td>none</td>
<td>4.258 b</td>
</tr>
<tr>
<td>RCp-2</td>
<td>diagonal marks across lateral surface of olecranon</td>
<td>dismembering</td>
<td>filleting</td>
<td>4.32</td>
<td>4.259 c</td>
</tr>
<tr>
<td>RCp-3</td>
<td>diagonal marks across medial face of olecranon</td>
<td>dismembering</td>
<td>filleting</td>
<td>4.32</td>
<td>4.259 a</td>
</tr>
<tr>
<td>RCp-4</td>
<td>marks on upper margin of medial side of semilunar notch</td>
<td>dismembering</td>
<td>disarticulation</td>
<td>4.32</td>
<td>4.260 a</td>
</tr>
<tr>
<td>RCp-5</td>
<td>transverse marks on medial, lateral, and anterior margin of radial tuberosities and on anconeal process</td>
<td>dismembering</td>
<td>disarticulation</td>
<td>4.31; 4.32; 4.260 a, b, c; 4.261 a</td>
<td>4.260 a, b, c; 4.261 a</td>
</tr>
<tr>
<td>RCp-6</td>
<td>clustered oblique &quot;chevron&quot; marks below lateral and medial tuberosities of radius</td>
<td>filleting</td>
<td>filleting</td>
<td>4.39</td>
<td>4.259 a, b, c</td>
</tr>
<tr>
<td>RCp-7</td>
<td>longitudinal and diagonal marks along medial and lateral surfaces of ulna shaft</td>
<td>filleting</td>
<td>filleting</td>
<td>4.39</td>
<td>4.259 a, c</td>
</tr>
<tr>
<td>RCp-9 (PJN)</td>
<td>longitudinal and diagonal marks on medial surface of radial tuberosity</td>
<td>none</td>
<td>filleting</td>
<td>none</td>
<td>4.259 a</td>
</tr>
<tr>
<td>RCp-10 (PJN)</td>
<td>marks on anterior border of olecranon</td>
<td>none</td>
<td>filleting</td>
<td>none</td>
<td>4.259 a, b</td>
</tr>
<tr>
<td>RCp-11 (PJN)</td>
<td>longitudinal and diagonal marks on lateral surface of radial tuberosity</td>
<td>none</td>
<td>filleting</td>
<td>none</td>
<td>4.259 b, c</td>
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<td>RCp-12 (PJN)</td>
<td>diagonal marks across lateral and medial surfaces of olecranon</td>
<td>none</td>
<td>filleting</td>
<td>none</td>
<td>4.259 a, c</td>
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<td>RCp-13 (PJN)</td>
<td>marks on margin of lateral side of semilunar notch</td>
<td>none</td>
<td>disarticulation</td>
<td>none</td>
<td>4.260 c</td>
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<tr>
<td>RCp-15 (PJN)</td>
<td>diagonal marks on posterior surface of radial tuberosity</td>
<td>none</td>
<td>filleting</td>
<td>none</td>
<td>4.259 d</td>
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<tr>
<td>RCp-17 (PJN)</td>
<td>diagonal mark on posterior edge of radial tuberosity, just below articular surface</td>
<td>none</td>
<td>disarticulation</td>
<td>none</td>
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<tr>
<td>RCs-1 (PJN)</td>
<td>marks on middle and proximal shaft on posterior surface</td>
<td>none</td>
<td>filleting</td>
<td>none</td>
<td>4.259 d</td>
</tr>
<tr>
<td>RCd-2</td>
<td>transverse marks across the styloid process and marks on articular surface of styloid process</td>
<td>dismembering</td>
<td>disarticulation</td>
<td>4.32</td>
<td>4.261 b</td>
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<tr>
<td>C-1</td>
<td>transverse cut along articular margin of cuneiform</td>
<td>dismembering</td>
<td>disarticulation</td>
<td>not shown</td>
<td>4.262 b</td>
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<tr>
<td>C-2 (PJN)</td>
<td>predominantly transverse cuts on cuneiform</td>
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<td>disarticulation</td>
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<td>C-3 (PJN)</td>
<td>predominantly transverse cuts on pisiform</td>
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<td>disarticulation</td>
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<td>C-4 (PJN)</td>
<td>predominantly transverse cuts on unciniform</td>
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<td>predominantly transverse cuts on scaphoid</td>
<td>none</td>
<td>disarticulation</td>
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<td>C-6 (PJN)</td>
<td>predominantly transverse cuts on magnum</td>
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<td>C-7 (PJN)</td>
<td>predominantly transverse cuts on lunate</td>
<td>none</td>
<td>disarticulation</td>
<td>none</td>
<td>4.262 b, d</td>
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<tr>
<td>C-8 (PJN)</td>
<td>predominantly longitudinal cuts on pisiform</td>
<td>none</td>
<td>skinning</td>
<td>none</td>
<td>4.263 a, c, d</td>
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<tr>
<td>C-9 (PJN)</td>
<td>longitudinal cut on posterior surface of lunate</td>
<td>none</td>
<td>skinning</td>
<td>none</td>
<td>4.263 d</td>
</tr>
<tr>
<td>PS-2</td>
<td>marks inside the acetabulum</td>
<td>dismembering</td>
<td>disarticulation</td>
<td>not shown</td>
<td>4.266 a</td>
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<tr>
<td>PS-3</td>
<td>marks across the lateral face of pubic</td>
<td>none</td>
<td>filleting</td>
<td>4.36</td>
<td>4.265 b</td>
</tr>
<tr>
<td>PS-5</td>
<td>cut or chop through the pubic symphysis</td>
<td>dismembering</td>
<td>splitting pelvis into two halves</td>
<td>4.36</td>
<td>4.264 a, c (not shown)</td>
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<tr>
<td>PS-8</td>
<td>marks below acetabulum on arm of ischium</td>
<td>dismembering</td>
<td>filleting</td>
<td>4.22, 4.24</td>
<td>4.265 b</td>
</tr>
<tr>
<td>PS-10</td>
<td>marks below acetabulum on arm of pelvis</td>
<td>dismembering</td>
<td>filleting</td>
<td>4.20, 4.22</td>
<td>4.265 a, b</td>
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<tr>
<td>PS-13 (PJN)</td>
<td>marks on articular surface of sacro-iliac joint</td>
<td>none</td>
<td>disarticulating sacrum from pelvis</td>
<td>none</td>
<td>4.264 d</td>
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<tr>
<td>PS-15 (PJN)</td>
<td>longitudinal and diagonal marks on ventral and dorsal surfaces of pubis arm</td>
<td>none</td>
<td>filleting</td>
<td>none</td>
<td>4.265 a, c</td>
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<td>PS-16 (PJN)</td>
<td>marks on edges of obturator foramen</td>
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<td>marks on ventral and lateral surfaces of ilium and ischium</td>
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<td>PS-20 (PJN)</td>
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<td>Fp-2</td>
<td>marks on the ball of femur head across fovea capitis</td>
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<td>4.25</td>
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<td>marks in the fossa along the neck of the femur</td>
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<tr>
<td>Fp-7</td>
<td>short marks on the neck of greater trochanter, anterior face</td>
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<td>4.37</td>
<td>4.267 b</td>
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<tr>
<td>Fp-9</td>
<td>longitudinal marks on upper shaft of femur on anterior and lateral surface</td>
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<td>filleting</td>
<td>4.37</td>
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<td>none</td>
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<td>Fs-1 (PJN)</td>
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<td>none</td>
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<tr>
<td>Fd-3</td>
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<td>none</td>
<td>disarticulation</td>
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<td>4.270 c</td>
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<tr>
<td>Fd-4</td>
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<td>filleting</td>
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<td>4.267 d</td>
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<td>filleting</td>
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<td>4.267 b, c</td>
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<td>skinning and/or filleting</td>
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<td>disarticulation</td>
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<td>TC-1</td>
<td>(Calcaneum) predominantly transverse marks on anterior and lateral surfaces, on distal quarter of bone</td>
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<td>disarticulation</td>
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<td>TC-3</td>
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<td>filleting, hanging carcass</td>
<td>filleting, hanging carcass</td>
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<td>(Calcaneum) transverse and diagonal cuts on posterior face, above articular surface</td>
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<td>TE-1</td>
<td>(External and middle cuneiform) transverse cut marks on medial, anterior, and posterior surfaces</td>
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<td>TI-1 (PJN)</td>
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<td>TNC-1</td>
<td>(Naviculo-cuboid) predominantly transverse cuts on all surfaces</td>
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<td>disarticulation</td>
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<td>transverse to diagonal cuts on medial surfaces of rib shafts</td>
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<td>evisceration</td>
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<td>marks on anterior and posterior margins of rib shafts</td>
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<td>none</td>
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<td>RS-8 (PJN)</td>
<td>marks on rib head, neck, and tubercle</td>
<td>none</td>
<td>disarticulating ribs</td>
<td>none</td>
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Figure 4.236. (a) ventral, (b) dorsal and (c) caudal views of cut marked crania (MNE = 3). Cut marks produced by disarticulation (D) and skinning (S) are depicted.
Figure 4.237. (a) right side and (b) left side views of cut marked crania (MNE = 3). Cut marks produced by disarticulation (D) and skinning (S) are depicted.
Figure 4.238. (a) medial (lingual) and (b) lateral (buccal) views of cut marked mandibles (MNE = 14). Cut marks produced by skinning (S), disarticulating the mandible from the skull (D), and removal of the tongue (RT) are depicted.
Figure 4.239. (a) dorsal, (b) ventral and (c) cranial views of cut marked atlases (MNE = 17). Cut marks produced by disarticulation are depicted.
Figure 4.240. (a) dorsal, (b) ventral and (c) cranial views of cut marked atlases (MNE = 17). Cut marks produced by filleting are depicted in (a), but (b) displays cut marks produced by filleting and/or evisceration. Cuts in (a) are coded CV-9 and those in (b) are coded CV-10.
Figure 4.241. (a) right side, (b) left side, (c) dorsal and (d) ventral views of cut marked axes (MNE = 17). Cut marks produced by filleting are depicted in (a), (b), and (c), but cuts produced by filleting and/or evisceration are displayed in (d). Except for cuts on centra, cuts in (a), (b), and (c) are coded CV-9 and those in (d) are coded CV-10.
Figure 4.242. (a) ventral, (b) dorsal, (c) right side and (d) left side views of cut marked cervical vertebrae (MNE = 7). Cut marks produced by disarticulation are depicted.
Figure 4.243. (a) ventral, (b) dorsal, (c) right side and (d) left side views of cut marked cervical vertebrae (MNE = 40). Except for cuts on centra, cut marks depicted in (b), (c), and (d) were produced by filleting, but (a) displays cut marks produced by filleting and/or evisceration. Cuts in (b), (c), and (d) are coded CV-9 and cuts in (a) are coded CV-10. Cuts on centra are coded CV-10.
Figure 4.244. (a) right side, (b) left side, (c) dorsal and (d) ventral views of cut marked front thoracic vertebrae (MNE = 33). Cut marks produced by evisceration (E) and filleting (F) are depicted.
Figure 4.245. (a) right side, (b) left side, (c) dorsal and (d) ventral views of cut marked rear thoracic vertebrae (MNE = 14). Cut marks produced by evisceration (E) and filleting (F) are depicted. All cuts in (c) were produced by filleting while those in (d) were produced by evisceration.
Figure 4.246. (a) right side, (b) left side, (c) dorsal and (d) ventral views of cut marked front thoracic vertebrae (MNE = 25). Cut marks produced by disarticulating ribs are depicted.
Figure 4.247. (a) cranial and (b) caudal views of cut marked front thoracic vertebrae (MNE = 33). Cut marks produced by disarticulating ribs are depicted.
Figure 4.248. (a) right side, (b) left side, (c) dorsal and (d) ventral views of cut marked rear thoracic vertebrae (MNE = 4). Cut marks produced by disarticulating ribs are depicted. All cut marks are coded TV-9.
Figure 4.249. (a) cranial and (b) caudal views of cut marked rear thoracic vertebrae (MNE = 4). Cut marks produced by disarticulating ribs are depicted. All cut marks are coded TV-9.
Figure 4.250. (a) right side, (b) left side, (c) dorsal and (d) ventral views of cut marked lumbar vertebrae (MNE = 26). With the exception of cut marks displayed in the expanded portion of (d), all cuts were produced by filleting. Cut marks in the expanded view were produced by evisceration. Filleting marks on centra are coded LV-5.
Figure 4.251. (a) right side, (b) left side, (c) dorsal and (d) ventral views of cut marked lumbar vertebrae (MNE = 5). Cut marks produced by disarticulation are depicted. Dotted lines represent saw marks.
Figure 4.252. (a) ventral, (b) dorsal and (c) cranial views of cut marked sacra (MNE = 18). Cut marks produced by evisceration (E), filleting (F), and disarticulation (D) are depicted. Cuts in (b) were produced by filleting except those marked D.
Figure 4.253. (a) right side and (b) left side views of cut marked sacra (MNE = 18). Cut marks produced by filleting (F) and disarticulation (D) are depicted.
Figure 4.254. (a) posterior, (b) lateral, (c) anterior and (d) medial views of cut marked scapulae (MNE = 30). Cut marks produced by filleting are depicted.
Figure 4.255. (a) posterior, (b) lateral, (c) anterior and (d) medial views of cut marked scapulae (MNE = 3). Cut marks in (a) and (d) were produced by disarticulation, but cuts in (b) were produced by filleting and/or disarticulation.
Figure 4. Distal view of cut marked scapulae (MNE = 18). Cut marks produced by filleting (S-11) and filleting and disarticulation (S-10) are depicted.
Figure 4.257. (a) medial, (b) anterior, (c) lateral and (d) posterior views of cut marked humeri (MNE = 30). Cut marks produced by filleting are depicted.
Figure 4.258. (a) medial, (b) anterior, (c) lateral and (d) posterior views of cut marked humeri (MNE = 4). Except for cuts Hd-2 and Hd-3, all cuts were produced by disarticulation. Hd-2 and Hd-3 were produced by filleting and/or disarticulation.
Figure 4.259. (a) medial, (b) anterior, (c) lateral and (d) posterior views of cut marked radio-ulnae (MNE = 30). Cut marks produced by skinning and filleting are depicted.
Figure 4.260. (a) medial, (b) anterior, (c) lateral and (d) posterior views of cut marked radio-ulnae (MNE = 4). Excluding RCp-8, cut marks produced by disarticulation are depicted. RCp-8 was produced by filleting and/or disarticulation.
Figure 4.261. (a) proximal and (b) distal views of cut marked radio-ulnae (MNE = 4). Cut marks produced by disarticulation are depicted.
Figure 4.262. (a) medial, (b) anterior, (c) lateral and (d) posterior views of cut marked carpals (MNE = 30 sets or 144 carpal bones). Cut marks produced by disarticulation are depicted.
Figure 4.263. (a) medial, (b) anterior, (c) lateral and (d) posterior views of cut marked carpals (MNE = 30 sets or 144 carpal bones). Cut marks produced by skinning are depicted.
Figure 4.264. (a) ventral, (b) lateral, (c) dorsal and (d) medial views of cut marked pelves (MNE = 26). Cut marks produced by splitting the pelvis (PS-5) and disarticulating it from the sacrum are depicted. Cuts at PS-11, PS-12, and PS-14 were produced by filleting and/or disarticulating the pelvis from the sacrum.
Figure 4.265. (a) ventral, (b) lateral, (c) dorsal and (d) medial views of cut marked pelves (MNE = 36). Cut marks produced by filleting are depicted.
Figure 4.266. (a) ventral, (b) lateral, (c) dorsal and (d) medial views of cut marked pelves (MNE = 5). Only cuts at PS-2 were unambiguously produced by disarticulating the femur from the pelvis. The remainder of the marks were produced by filleting and/or disarticulation.
Figure 4.267. (a) medial, (b) anterior, (c) lateral and (d) posterior views of cut marked femora (MNE = 34). Cut marks produced by filleting are depicted.
Figure 4.268. (a) proximal, (b) oblique distal, (c) distal and (d) oblique proximal views of cut marked femora (MNE = 34). Cut marks produced by filleting are depicted.
Figure 4.269. (a) medial, (b) anterior, (c) lateral and (d) posterior views of cut marked femora (MNE = 5). Cut marks at Fp-2, Fp-12, Fp-13, and Fd-7 were produced by disarticulation while other cuts were produced by filleting and/or disarticulation.
Figure 4.270. (a) proximal, (b) oblique distal, (c) distal and (d) oblique proximal views of cut marked femora (MNE = 5). Cut marks at Fp-2, Fd-3, and Fd-8 were produced by disarticulation. Remaining cuts were produced by filleting and/or disarticulation.
Figure 4.271. (a) medial, (b) anterior, (c) lateral and (d) posterior views of cut marked tibiae (MNE = 34). All cuts excluding Td-5 and Td-6 were produced by filleting. Cuts marked Td-5 were produced by skinning and those marked Td-6 were produced by skinning and/or filleting.
Figure 4.272. (a) medial, (b) anterior, (c) lateral and (d) posterior views of cut marked tibiae (MNE = 5). Cut marks produced by disarticulation are depicted.
Figure 4.273. (a) proximal and (b) distal views of cut marked tibiae (MNE = 5). Cut marks produced by disarticulation are depicted.
Figure 4.274. (a) medial, (b) anterior, (c) lateral and (d) posterior views of cut marked tarsals (MNE = 34 sets or 132 tarsal bones). Cut marks produced by disarticulation are depicted.
Figure 4.275. (a) medial, (b) anterior, (c) lateral and (d) posterior views of cut marked tarsals (MNE = 34 sets or 132 tarsal bones). Cut mark TLM-1 was produced by skinning, cuts marked TC-3 were produced by filleting, hanging the carcass, and the remaining cuts were produced by skinning and/or filleting.
Figure 4.276. (a) medial, (b) lateral and (c) proximal views of cut marked front ribs (MNE = 24). Cuts marked RS-5 were produced by evisceration, cuts marked RS-8 were produced by disarticulating ribs, and cuts marked RS-3 were produced by evisceration, filleting, and/or disarticulating ribs.
Figure 4.277. (a) medial, (b) lateral and (c) proximal views of cut marked front ribs (MNE = 24). Cut marks produced by filleting are depicted.
Figure 4.278. (a) medial, (b) lateral and (c) proximal views of cut marked middle and rear ribs (MNE = 108). Cuts marked RS-5 were produced by evisceration, cuts marked RS-8 were produced by disarticulating ribs, and cuts marked RS-3 were produced by evisceration, filleting, and/or disarticulating ribs.
Figure 4.279. (a) medial, (b) lateral and (c) proximal views of cut marked middle and rear ribs (MNE = 117). Cut marks produced by filleting are depicted.
4.5.3. Comparing small and large bovids

Although the proportions with which cut marks were produced at different anatomical locations by various butchery activities are in many cases similar for both size groups, the above tables show some variability and differences. Some of these differences are highlighted below in brief comparisons between small and large bovids for different skeletal elements. As mentioned at the outset of this chapter, adequate data are available for more detailed comparisons between the size groups, but here I focus on general similarities and differences.

The most striking difference between small and large bovids lies in the frequency of cut marks produced per butchered bone. To compare the frequencies of cut marks per butchered bone between the two size groups, only cut marks resulting from activities conducted consistently for both groups were included in the analysis. A Mann-Whitney U-test\(^9\) showed that the overall frequency of cut marks (produced by activities carried out on all animals) per butchered skeletal element in large bovids is significantly higher than in small bovids (\(U_s = 269.5, P < 0.001\)). At a more detailed level, Tables 4.38, 4.39\(^10\) (filleting cut marks), and 4.40 (filleting and disarticulation cut marks) and Figures 4.280 (see footnote\(^\text{10}\)) and 4.281 (filleting and disarticulation cut marks) show that large bovids retain considerably higher numbers of cut marks per butchered element for almost every skeletal element relative to small bovids.

The above-mentioned tables are given to provide the reader with a sense of the proportion with which butchered elements are cut marked, as well as the number of cut marks which can be expected to occur per butchered element and per cut marked element. This pattern can be expected at archaeological sites where butchers had early access to carcasses and where carcasses were processed fully and systematically. I use the term “processed fully” to indicate that all meat was removed from the bones since this research is concerned only with meat removal. The term “processed fully” as used here does not imply that other activities such as preparing bones for marrow or grease extraction were also carried out. Similarly, Figures 4.280 and 4.281 present the number of cut marks per butchered element for both small and large bovids.

\(^9\) This test was employed throughout to compare the frequencies of cut marks between the two size groups.
\(^\text{10}\) Tables 4.38, 4.39 and Figure 4.280 include all filleting, evisceration, and disarticulation marks where disarticulation was performed consistently for both bovid size groups (e.g., disarticulation of skulls and metapodials).
Table 4.38. Summary of filleting cut mark frequencies for axial skeletal elements of small and large bovids. See the above figures or Appendix B for descriptions of acronyms used for anatomical locations or portions. The following acronyms apply to tables 4.38, 4.39, and 4.40: NBE = number of butchered elements, NCE = number of cut marked elements, BE = butchered element, CE = cut marked element. NCE as % of NBE = NCE divided by NBE and multiplied by 100. Number of cut marks per BE and CE = the number of cut marks divided by NBE and NCE respectively.

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Table 4.39. Summary of filleting cut mark frequencies for appendicular skeletal elements of small and large bovids. See the above figures or Appendix B for descriptions of acronyms used for anatomical locations or portions.

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</table>
Figure 4.280. Frequency distribution of cuts resulting from butchery activities consistently applied to small and large bovids in this study (adapted from Milo 1994, Figure 30). Values represent the number of cut marks per butchered skeletal element and portion. Values to the left are for small bovids and those to the right for large bovids.
Figure 4.281. Frequency distribution of cuts resulting from filleting and disarticulation (adapted from Milo 1994, Figure 30). Values represent the number of cut marks per butchered skeletal element and portion. Values to the left are for small bovids and those to the right for large bovids.
Butchery procedures employed for small and large bovids were more or less the same. Where differences were observed they are described above in the bone by bone accounts. The most striking difference between processing small and large bovid carcasses lies in the number of cutting actions and amount of time taken to complete butchery tasks. In other words, more effort was required for processing large bovids than small bovids. This applies to all butchery activities described above. This observation is borne out in the summary tables (Tables 4.38, 4.39 and 4.40) and is relevant to identifying carcass acquisition strategies employed by humans and hominids. As demonstrated above, results from this study show that when access to carcasses is not an issue and when carcasses were processed fully and systematically, large bovid bones retained significantly more cut marks per butchered element than small bovids. Consequently, we may expect that if hominids had early access to animal carcasses, the bones of large bovids from archaeological sites should retain more cut marks than those of small bovids. It follows that if large bovid bones from an archaeological site retain fewer cut marks per skeletal element than bones from small bovids, the latter were more likely acquired soon after the animal died whereas large bovids were attained later. This issue is discussed in more detail in chapter 6.

I now give a bone by bone account comparing the results from butchery observations of small and large bovids. Mann-Whitney U-Tests (Sokal & Rohlf 1981) were used to compare the samples.

4.5.3.1. Cranium

As mentioned earlier, the sample is small and therefore no definitive interpretations are offered, but a few generalizations are made. For small bovids, transverse cuts made during disarticulating the skull from the atlas were made mostly to the ventral surface of the neck with some cutting strokes applied to the dorsal surface. In contrast, transverse cuts made while disarticulating large bovid crania were made to the ventral surfaces and sides of the neck with some cutting actions applied to the dorsal surfaces. This is due to the fact that large bovid heads could not be snapped as easily from the neck as small bovid heads, and therefore large bovids required more cutting than small bovids. The number of cut marks on butchered large bovid crania is more than twice that for butchered small bovid crania. However, the sample is too small to test this observation statistically. Cut marks on large bovid crania are more dispersed and occur on more anatomical locations than those on small bovid crania.
4.5.3.2. Mandible

The figures show that in some cases skinning and filleting marks for both size groups are located at the same anatomical locations. During tongue removal, numerous cut marks were produced on the lingual surfaces of the mandibles of large bovids, but no cuts were recorded here on small bovid mandibles. Similarly, disarticulation produced numerous cut marks on large bovid mandibles while no unambiguous disarticulation marks were recorded on small bovid mandibles. When disarticulation cuts are excluded, there is not a significant difference between the frequencies of cut marks on small and large bovid mandibles ($U_s = 20$, $P > 0.10$). Large bovids are cut marked at more anatomical locations than small bovids.

4.5.3.3. Atlas

Large bovids retain significantly higher frequencies of filleting cut marks than small bovids ($U_s = 68$, $P < 0.001$). There is not a significant difference in the frequencies of disarticulation marks between small and large bovids ($U_s = 50.5$, $P = 0.10$).

4.5.3.4. Cervical vertebra

Large bovids retain significantly higher frequencies of filleting marks than small bovids ($t_s = 5.124$ [$n_1 > 20$], $P < 0.001$). Table 4.38 shows that large bovid cervical vertebrae retain more than four times the number of filleting cut marks per butchered element than those of small bovids.

4.5.3.5. Thoracic vertebra

Large bovids retain significantly higher frequencies of filleting cut marks than small bovids ($t_s = 8.744$ [$n_1 > 20$], $P < 0.001$). Table 4.38 shows that butchered elements of large bovids retain nearly five times as many filleting cut marks as those of small bovids. There is not a significant difference in the frequencies of evisceration cut marks on small and large bovids ($t_s = 2.067$ [$n_1 > 20$], $P > 0.05$). However, a higher proportion of large bovid thoracic vertebrae (24.8%) retain evisceration cuts than those of small bovids (11%). During the disarticulation of ribs from thoracic vertebrae, large bovids retain significantly higher frequencies of cut marks than small bovids ($t_s = 3.378$ [$n_1 > 20$], $P < 0.01$).
4.5.3.6. **Lumbar vertebra**

Significantly higher frequencies of filleting cut marks were recorded for large than small bovids ($t = 5.543$ [n$_1 > 20$, $P < 0.001$]). More than twice the number of filleting cut marks per butchered element were produced for large bovids (Table 4.38). The most marked difference lies in the number of cut marks produced at the rib facets during the disarticulation of ribs. Many more cuts were produced on rib facets of large bovids compared to those of small bovids. This stems from the fact that large bovid articulations are stronger than those of small bovids and therefore the former require notably more cutting.

4.5.3.7. **Sacrum**

Since only one small bovid sacrum was disarticulated from the pelvis, the paucity of cut marks at the sacro-iliac joint of small bovids is an artefact of the experiments. The same explanation applies to the low number of cut marks on the cranial articular processes of small bovids. Numerous cut marks were produced at similar positions on the sacral wings of both small and large bovids during removal of the tenderloins. In contrast, only one cut mark was produced on the dorsal spine of small bovid sacra, while numerous cuts were produced on dorsal spines of large bovids during the removal of sirloins. Filleting cut marks are significantly more numerous for large than for small bovids ($U = 61$, $P < 0.01$). Table 4.38 shows that nearly six times the number of filleting cut marks per butchered sacrum occur in large bovids than in small bovids.

4.5.3.8. **Scapula**

Only one small bovid scapula was disarticulated from the humerus and no cut marks were produced by this activity. On the other hand, this activity was performed on three large bovid scapulæ and numerous cut marks were produced. Large bovids retain significantly higher frequencies of filleting cut marks than small bovids ($U = 206$, $P < 0.001$). Table 4.39 shows that three times more filleting cut marks were produced per butchered element for large bovids than for small bovids.
4.5.3.9. Humerus

Only one small bovid humerus was disarticulated from both the scapula and radio-ulna, and therefore the number of cut marks produced by this activity is not meaningfully comparable to those produced on large bovid elements. However, there is significant overlap in the anatomical location and proportions of cut marks at various locations as produced by filleting (see the above tables and figures). Significantly higher frequencies of filleting cut marks were recorded for large than for small bovids \( (U_s = 168.5, P < 0.01) \). More than twice the number of filleting cut marks per butchered element was recorded for large than small bovids (Table 4.39).

4.5.3.10. Radius

Although the figures show a certain degree of overlap in the anatomical placement of cut marks on small and large bovids, the tables show differences between the two size groups in the proportions in which cut marks were produced at different anatomical locations. Large bovids retained significantly higher frequencies of filleting cut marks than small bovids \( (U_s = 176.5, P < 0.005) \). Large bovids retain four times more filleting cut marks per butchered element than small bovids (Table 4.39).

4.5.3.11. Ulna

The figures show a certain degree of overlap in the location of cut marks on small and large bovid ulnae. However, the tables show some discrepancies in the proportions with which cut marks were produced at different anatomical locations. Table 4.39 shows that only 33% of small bovid ulnae were cut marked while 94% of large bovid ulnae bear cut marks. Not only were small bovid elements less frequently cut marked, but when cut they also retained significantly fewer filleting cut marks than elements of large bovids \( (U_s = 193, P < 0.001) \). Large bovid ulnae retain more filleting cut marks per butchered element than those of small bovids do by a factor of 14.
4.5.3.12. Carpals

The above figures show a certain degree of overlap in the anatomical placement of cut marks on small and large bovid carpal bones. However, a greater variety of carpals are cut marked in large bovids when compared to small bovids (see the above tables). Nevertheless, the most frequently cut marked carpal for both small and large bovids is the unciform. Significantly higher frequencies of cut marks were recorded on large bovid carpals than those of small bovids ($U_s = 177, P < 0.005$). Large bovid carpals retain six times the number of cut marks per butchered element than those of small bovids (Table 4.39).

4.5.3.13. Pelvis

Large bovids retained significantly higher frequencies of both filleting and disarticulation cut marks than small bovids ($U_s = 304.5$ and $U_s = 175$ [respectively], $P < 0.001$). More than six times the number of filleting cut marks per butchered element were produced on large bovids than on small bovids (Table 4.39).

4.5.3.14. Femur

Although some overlap in the anatomical locations of cut marks on small and large bovid femora is evident in the above figures, it is also clear that epiphyses of large bovids are more cut marked than those of small bovids. This results from the fact that more meat is associated with large bovids and therefore more effort is put into removing ‘scraps’ of meat than when processing small bovids. The tables show that shaft portions are more frequently cut marked than epiphyseal portions during filleting. For small bovids the distal shaft retains more cut marks while the proximal shaft retains more cut marks in large bovids. A striking difference between small and large bovids can be seen in the disarticulation category of the above tables. For small bovids, the vast majority of disarticulation marks occur at the distal epiphysis, while for large bovids the vast majority of marks produced by this activity are located at the proximal epiphysis. However, the sample is small and this observation should be viewed as a hypothesis and is not conclusive. The most marked difference between the two size groups is that large bovid femora retain significantly more filleting cut marks than those of small bovids ($U_s = 240.5, P < 0.001$). Large bovids retain three times the number of filleting cut marks per butchered element than those of small bovids (Table 4.39).
4.5.3.15. Tibia

Although the above figures show a certain degree of overlap in the distribution of cut marks on small and large bovid tibiae, the epiphyseal ends of large bovids are more frequently cut marked than those of small bovids. The above tables show that filleting marks are most common on the mid shafts of both small and large bovid tibiae. Significantly higher frequencies of filleting cut marks were recorded for large bovids than for small bovids ($U_s = 198.5, P < 0.005$).

4.5.3.16. Patella

Small bovid patellae were never cut marked, while the above figures and tables show that large bovid patellae were frequently cut marked. Table 4.39 indicates that 70% of large bovid butchered patellae retained cut marks. Large bovid patellae retained significantly higher frequencies of filleting cut marks than those of small bovids ($U_s = 240, P < 0.001$).

4.5.3.17. Tarsals

The above figures show a certain degree of overlap in the placement of cut marks on small and large bovid tarsal bones. However, the proportions with which cut marks were produced at different tarsals varies between the two size groups (see above tables). The most obvious difference is that for small bovids the most frequently cut marked tarsal bone is the astragalus, while for large bovids it is the naviculo-cuboid. The lateral malleolus of large bovids was never cut marked, while the cuneiforms of small bovids were unmarked. The frequencies of cut marks are significantly higher for large than small bovids ($U_s = 234, P < 0.001$). Table 4.39 shows that four times the number of cut marks were produced on butchered large bovid tarsal bones compared with those of small bovids.

4.5.3.18. Ribs

The frequencies of cut marks produced by filleting, evisceration, and disarticulating ribs are not significantly different between the two bovid size groups ($t_s = 1.465 \ [n_1 > 20], P > 0.01$; $t_s = 1.253 \ [n_1 > 20], P > 0.2$; and $t_s = 0.225 \ [n_1 > 20], P > 0.5$ respectively). However,
evisceration produces more cut marked ribs during the butchery of large bovids (33%) than small bovids (20%).

4.5.4. Butchering with metal and stone

Although many butchery activities during my observations were carried out with stone as well as metal, I provide some basic generalizations here. About 15% of the butchery activities performed in this study were carried out with stone tools. More detailed analysis of comparing stone versus metal butchery is planned for future research. Most butchery activities were carried out in the same fashion regardless of the raw material utilized. However, certain tasks, specifically where the point of a metal blade was used, could not be performed with the stone flakes I struck. These include splitting the pelvis at the pubic symphysis, inserting the point of the blade into the acetabulum while disarticulating the femur from the pelvis, and inserting the point of the blade between vertebral centra when disarticulating vertebral portions. Having said this, it should be noted that the stone flakes used during butchery were not fashioned for any specific task, and it is conceivable that pre-iron age butchers fashioned pointed stone artefacts specifically for performing butchery tasks where a sharp point was required. More research regarding this issue is required.

While cutting strokes were employed when using metal, sawing motions were common when stone flakes were used. This often resulted in more cut marks being produced per activity when using stone as opposed to metal. Additionally, video footage shows that more cuts were required for a given butchery task when using stone rather than metal. One reason for this may be because stone flakes usually had shorter cutting edges than metal blades. In other words, fewer strokes were required with a longer cutting edge.

Depending on the size of the animal and the butchery tasks being performed, the use life of stone flakes was remarkably longer than I anticipated. The butcher was able to butcher half a springbok with one stone flake and at the end of the task he suggested that the tool was still sharp enough for additional butchery. Further analysis of my data will shed more light on this issue in the near future.

An important concern is whether a study conducted primarily with metal tools is applicable to studies of cut marks made with stone tools. Because a limited number of butchery activities were performed with stone in this study, I am unable to address this issue
quantitatively. An additional complicating factor concerning the resolution of this concern is that no extant hunter gatherers butcher animals with stone tools (e.g. Gifford-Gonzalez 1989a). We are not, therefore, in a position to observe or replicate butchery as performed by butchers habitually using stone tools. Consequently, we are compelled to formulate an understanding of the link between butchery activities and their resulting signatures (including cut marks) by studying butchery in modern contexts.

Fortunately, butchery, and specifically the removal of flesh from bones, can be viewed as an engineering problem. The anatomy of animals, and specifically the relationship between bones and flesh, has not changed significantly since human ancestors started butchering animals at least two million years ago. Butchery tasks, such as removing the flesh from a femur, demand roughly the same activities with similar tools, namely, cutting through flesh at certain anatomical locations with a sharp edged object. This is evidenced by the presence of cut marks on bones from Pleistocene and Plio-Pleistocene archaeological sites at anatomical locations more or less identical to those produced by metal tools in a modern setting.

As discussed previously, researchers have found that stone tools can be used effectively in ways different from those employed during butchery with metal tools (e.g. Milo 1994). Nevertheless, it is encouraging that cut marks have been recorded, on bones from a wide variety of archaeological sites, at anatomical locations comparable to those presented in this thesis and by Binford (1981). Additionally, statistical analysis in section 6.4.3.2. reveals that cut mark frequencies on bones of small bovids from MRM and Klasies River Mouth are not significantly different. These observations lend strength to the idea that observations of butchery conducted with metal tools are useful guides for interpreting cut marked bones where stone tools were employed.

### 4.5.5. Disarticulation and filleting as indicators of carcass acquisition strategies

This actualistic study revealed that filleting actions, and hence filleting cut marks, frequently affect near epiphyseal portions of limb bones and in several cases articular surfaces of epiphyses. Table 4.41 shows that this is most apparent at both the proximal and distal epiphyses of the humerus, the proximal epiphysis of the ulna (including the olecranon), the proximal and distal epiphyses of the femur, and the areas immediately adjacent to the acetabulum and sacro-iliac joint (see Figures 4.257, 4.259, 4.267, 4.264, and 4.265
respectively). This finding has profound implications for interpreting the anatomical placement of cut marks with respect to butchery practices and consequently the animal carcass acquisition strategies of hominids. Based mostly on Binford’s behavioural correlates (1978, 1981, but also on Gifford-Gonzalez 1998, Guilday et al. 1962, Hole et al. 1969; von den Driesch and Boessneck 1975; Wheat 1972, Frison 1978), numerous researchers (cited in chapters 5 and 6) have interpreted cut marks on epiphyses as disarticulation marks and have for that reason attributed late access or scavenging as the behaviour reflected by those cut marks. Observations and data from the current study show, unequivocally, that filleting leaves cut marks at anatomical locations that have previously been linked with disarticulation. This issue is further investigated and discussed in chapter 6, section 6.3. As mentioned previously, when cut marks occur in anatomical locations where butchery activities overlap, the angulation (type) of cut marks is an important factor in determining behavioural correlates. More detailed analysis of cut mark attributes, particularly angulation (type), produced by specific butchery procedures is planned for the near future.

Table 4.41. Proportional distribution of cut marks produced by filleting exclusively. Values represent percentages of cut marks at anatomical locations by skeletal element. For example, for the humerus, 22% of all filleting marks recorded on the humerus are located on proximal epiphyses (PE). Values to the left of vertical bars are for small bovids and those to the right for large bovids. PE for ulna includes the olecranon. Na = not applicable.

<table>
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<tr>
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<th>DS</th>
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<th>NE</th>
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Having established that cut marks produced exclusively by filleting do occur at anatomical locations previously linked with disarticulation, the next step was to ascertain whether filleting, when compared with filleting and disarticulation, produced similar or different cut mark frequencies at various anatomical portions. The proportional distribution of cut marks at different anatomical locations have frequently been used as an indicator of
butchering as well as carcass acquisition strategies when interpreting cut marked bones from hominid sites (e.g., Bunn & Kroll 1986; Milo 1994, 1998). Since only one small bovid was filleted and disarticulated in this study, I restrict the following comparisons and discussion to large bovids. Data for both bovid size groups are presented in Table 4.42. The numbers of butchered elements (NBE) are presented in Tables 4.38, 4.39 and 4.40.

The following comparisons are restricted to the appendicular skeleton, specifically including bones that are associated with meat (e.g., Binford 1978, 1981; Blumenschine & Caro 1986). This decision was partly made because the literature concerning reconstruction of hominid subsistence strategies relies most commonly on cut marks located on appendicular bones. In addition, some of these elements rank high in the carnivore consumption sequence, and are therefore important indicators of early or late access to animal carcasses (Blumenschine 1986a, 1986c, 1987, 1988b, 1991). I place the scapula, humerus, pelvis, and femur in the meaty bone category, and the tibia and radio-ulna in the less meaty category. The distal portions (distal shafts and distal epiphyses) of radio-ulnae and tibiae are encased by tendons, ligaments, and skin (personal observations), and therefore distal epiphyses of these elements are excluded from the epiphyseal comparisons. The Mann-Whitney U-test was used to check for differences in the frequencies of cut marks at different anatomical portions as produced by exclusively filleting and filleting and disarticulation. Due to logistical constraints during fieldwork, the sample of filleted and disarticulated elements is quite small. The results are preliminary and additional research is required to test or substantiate these results. Nevertheless, some results presented below have significant implications for previous interpretations of hominid subsistence strategies as well as the methodology for quantifying and analyzing cut mark frequencies at different anatomical portions.

The frequencies of cut marks at proximal epiphyses and proximal shafts (PSH) (excluding scapulae and pelves), as used by Bunn and Kroll (1986: 437), are not significantly different when comparing filleting exclusively with filleting and disarticulation ($U_s = 62.5$, $P > 0.10$). Similarly, the frequencies of cut marks at distal epiphyses and distal shafts (DSH) (including scapulae [DS and DE] and pelves [NE and EP]), as used by Bunn and Kroll (1986: 437), are not significantly different when comparing filleting with filleting and disarticulation ($U_s = 90.0$, $P > 0.10$). The frequencies of cut marks at proximal shafts (PS) (including pelves [NE]), distal shafts (DS), and mid shafts (MS), as used in this study, are not significantly different when comparing filleting with filleting and disarticulation ($U_s = 24.0$, $P > 0.10$; $U_s = 22.0$, $P > 0.10$; and $U_s = 29.0$, $P > 0.10$ respectively).
In contrast, the frequencies of cut marks at epiphyses (including cut marks per epiphysis for all epiphyses) are significantly different when comparing filleting with filleting and disarticulation ($U_s = 68.0, P < 0.01$). Interestingly, the frequencies of cut marks at distal epiphyses of the scapulae, proximal epiphyses of humeri, proximal epiphyses of radii, the olecranon of ulnae, distal epiphyses of femora, and proximal epiphyses of tibiae are not significantly different when comparing filleting with filleting and disarticulation ($U_s = 63.0, P > 0.10$; $U_s = 19.0, P > 0.10$; $U_s = 7.5, P > 0.10$; $U_s = 20.0, P > 0.10$; $U_s = 20.0, P > 0.10$; and $U_s = 16.0, P = 0.10$ respectively). When all epiphyses are lumped there is a significant difference between the exclusively filleted sample and the filleted and disarticulated sample. But as shown above, when bone by bone comparisons are made, there are some that are not significantly different. Proximal epiphyses of ulnae are excluded due to sample size. In some cases, as indicated by the frequencies of cut marks per butchered element (Table 4.42), these results may be due to the small sample. Therefore it is crucial to increase the filleted and disarticulated sample. The frequencies of cut marks at the acetabulum (EP) are not significantly different when comparing filleting with filleting and disarticulation, but the statistic shows that the difference is tending towards being significant ($U_s = 11.5, P > 0.05$ and $P < 0.10$). An increased sample is required to test this suggestion.

Interestingly, the frequencies of cut marks at distal epiphyses of humeri and proximal epiphyses of femora are significantly different when comparing filleting with filleting and disarticulation ($U_s = 31.0, P = 0.05$ and $U_s = 37.5, P < 0.01$ respectively). In both cases, filleting and disarticulation produced significantly higher frequencies of cut marks than filleting alone. The implications of these results are discussed in more detail in chapter 5.
Table 4.42. Frequency and percentage distribution of cut marks produced by exclusively filleting as well as filleting and disarticulation combined. Numbers of butchered elements are presented in Tables 4.39 and 4.40.

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4.5.6. Evisceration as an indicator of carcass acquisition strategies

Certain cut marks on the ventral surfaces of centra of cervical, thoracic, and lumbar vertebrae as well as medial surfaces of ribs are attributed to evisceration. To the best of my knowledge, this is the first study that has revealed the presence and relevance of these marks. Particularly on the medial surfaces of ribs, these cut marks are unmistakably the result of evisceration since viscera, and no meat, are associated with the medial surfaces of ribs. Since viscera are of the first animal tissues consumed in the carnivore consumption sequence (e.g., Blumenschine 1985, 1986a, 1988a; Blumenschine & Marean 1993; Bunn & Ezzo 1993; Cavallo & Blumenschine 1989; Kruuk 1972; Schaller & Lowther 1969), evisceration cut marks on ribs are argued here to be a critical and reliable indicator of early access to animal carcasses. This finding has major implications for reconstructing hominid behaviour regarding early or late access to animal products. This issue is investigated and discussed in more detail in chapter 5, section 5.4.
CHAPTER 5

THE ANATOMICAL PLACEMENT OF CUT MARKS: COMPARING RESULTS FROM THE MRM STUDY WITH BINFORD'S OBSERVATIONS OF NUNAMIUT BUTCHERY PRACTICES

5.1. INTRODUCTION

Chapters 1 and 2 present an overview of the historical trajectory of butchery studies with a focus on the nature and use of ethnographic and experimental research in establishing analogues for interpreting cut marked bones in zooarchaeological assemblages. In this chapter I focus on the anatomical placement of cut marks and their associated behavioural functions.

Valuable insights stemmed from the above-mentioned studies, and the lists of references are incomplete, but I restrict discussions in this chapter to the behavioural meaning attributed to cut mark placement and orientation, because the MRM data are pertinent to that issue. In this regard, of the studies cited above, Binford’s observations of butchery by Nunamiut Eskimo in Alaska and his documentation of the resultant cut marks, remains the only publication of detailed descriptions of butchery activities and tabulation as well as graphic presentation of cut mark placement and orientation along with their associated butchery functions (1978, 1981 Table 4.04, pp. 136-141). I allude to the concern regarding analysts performing their own butcheries in section 6.4, and for more detail see for example Fisher (1995), Haynes (1991), and Milo (1994, 1998). For the above reasons, I focus here on comparing the results of the MRM study with Binford’s observations of Nunamiut butchery practices, specifically with respect to cut mark locations, orientations, and their behavioural correlates.

Although percussion and chop marks, among other butchery marks, are commonly recorded in archaeological assemblages and are valuable for assessing butchery practices, the discussion of butchery marks presented here focuses on cut marks, because the MRM data are pertinent to this category of butchery mark. This is because butchery activities were performed with metal knives and occasionally stone flakes during the MRM study, and because the primary goal of butchery at MRM was to deflesh bones and occasionally to disarticulate elements at my request.

I begin with a brief discussion of the interpretative value of cut mark placement and orientation for reconstructing butchery and carcass acquisition strategies in section 5.2. Binford’s methodology for documenting butchery activities and recording cut marks for constructing his interpretative framework (1981), as well as the methodology employed during the MRM study are summarised in section 5.3. In the same section I highlight certain contextual issues affecting the merit of employing Binford’s (1981) framework for interpreting cut marked bones from archaeological sites in situational and climatic conditions.
different from those prevailing in Alaska. In section 5.4 I discuss the behavioural correlates that Binford attributed to cut marks with specific orientation and located at particular anatomical loci in view of observations made at MRM. Finally, I briefly discuss the merits of Binford’s interpretative framework for reconstructions of butchery and carcass acquisition strategies in section 5.5. More detailed discussions concerning the use of Binford’s framework are presented in sections 6.3 and 6.4 (also see e.g., Bartram 1993a; Bunn & Kroll 1988b; Gifford-Gonzalez 1989a, 1993; Lupo 1994; Milo 1994, 1998; O’Connell et al. 1988a, 1988b). In section 5.5 I propose that the tabulation of cut mark placement and their behavioural correlates presented in Tables 4.37 and 5.1 is founded on an unprecedentedly controlled actualistic assemblage that provides a new interpretative framework for identifying specific butchery operations. It is stressed that the MRM scenario should not be considered as the ‘Rosetta Stone’ for interpreting cut marks.

In my opinion, reconstructing butchery and carcass acquisition strategies can not be based solely on cut mark placement and orientation, but rather on a combination of the latter and the proportional distribution of cut mark frequencies across different anatomical portions of the skeleton (also see for example Bunn & Kroll 1986; Lyman 1994b; Milo 1994, 1998; Shipman 1986a). This proposition is elaborated on and put into practice in sections 6.3, 6.4, and 6.5. Although the use of the proportional distributions of cut marked specimens is not entirely new (e.g., Bunn 1986; Shipman 1986a), the method employed here focuses on numbers of cut marks and not numbers of cut marked specimens (also see Bartram 1993a; Milo 1994, 1998). More importantly, the interpretative framework used here was controlled in such a way as to circumvent the dilemma of distinguishing cut marks resulting from palimpsests of butchery activities (see Binford 1988).

5.2. CUT MARKS: THEIR ANATOMICAL PLACEMENT, ORIENTATION, AND INTERPRETATIVE VALUE

The significance of examining bone surfaces for traces of activities performed by humans and other agents in the past, including cut marks, is emphasised in the perception that “The detailed study of surface modifications on archaeological bones has assumed fundamental importance in zooarchaeological analyses of vertebrate remains” (Fisher 1995: 7). The presence of indisputable cut marks and percussion damage on animal bones from archaeological sites is currently considered the most reliable gauge of hominid involvement
with animal carcasses (Behrensmeyer 1986; Binford 1981; Blumenschine 1986b, 1988a; Blumenschine et al. 1996; Bunn 1983b; Bunn & Ezzo 1993; Bunn & Kroll 1986; Fisher 1995; Lupo 1994; Lyman 1994b; Potts 1984b; Shipman 1986a; Shipman & Rose 1983b). Having established that certain bone surface modifications are cut marks made by people, “Analysts then typically examine additional attributes of the marks, particularly their anatomical location and orientation (Lyman 1987a; e.g., Gibert and Jimenez 1991; Noe-Nygaard 1989)” (Lyman 1994b: 297). A criterion considered important for the identification of cut marks is that they have an anatomical purpose (Guilday et al. 1962).

Regarding the value of cut mark placement, Lyman stated that “the myriad factors affecting mark placement and orientation tend to weaken the utility of the purposiveness criterion for assigning an unambiguous function to a particular class of marks” (1987a: 264). Lyman provides no data that directly address this issue, and hence he only provides speculation. Below I aim to demonstrate that Lyman’s view is overly pessimistic, and that certain butchery activities result in cut marks with particular orientation and anatomical placement. In view of the MRM study, numerous cut marks can be assigned unambiguous behavioural correlates (see Table 4.37). However, as is evident in Table 5.1, cut marks at some anatomical locations are ambiguous indicators of specific butchery activities. In section 4.5.5 above, the interpretative value of cut mark placement and their frequencies, specifically the proportional distribution of cut marks across different anatomical portions produced by filleting as opposed to disarticulation, is investigated and discussed in more detail.

The following summary focuses on cut mark studies of bones from Plio-Pleistocene and Upper Pleistocene sites. A great deal of attention has been given to these sites because of the importance of understanding the early stages of hominid behavioural evolution (Plio-Pleistocene) as well as the timing of the emergence of behavioural modernity in hominids (Upper Pleistocene). Based on the presence, frequencies, and anatomical placement of cut marks, interpretations of hominid involvement with animal carcasses have ranged from passive scavenging to active hunting (e.g., Binford 1981, 1984c, 1988; Bunn 1986; Bunn & Blumenschine 1987; Bunn & Ezzo 1993; Bunn & Kroll 1986, 1988b; Lupo 1994; Milo 1994, 1998; Potts & Shipman 1981; Selvaggio 1994, 1998; Shipman 1986a; Zeleznik et al. 1988). These studies were geared specifically toward investigating butchery and carcass acquisition strategies practiced by hominids in the Plio-Pleistocene and Upper Pleistocene. Butchery and carcass acquisition strategies were then used by these scholars for reconstructions of the evolution of hominid behaviour, specifically the nature of social behaviours such as
cooperative and coordinated group activities for hunting and/or scavenging (see references cited above and below).

The anatomical placement of certain cut marks were used in numerous studies as evidence for specific butchery activities such as filleting and disarticulation (e.g., Binford 1981, 1984c, 1988; Bunn 1981, 1982b, 1983b; Bunn & Ezzo 1993; Bunn & Kroll 1986, 1988b; Gifford-Gonzalez 1989a; Lupo 1994; Milo 1994, 1998; Potts & Shipman 1981; Shipman 1983, 1986a, 1986b). In turn, these activities were transformed into reconstructions of hominid carcass acquisition strategies, including several versions along the hunting-scavenging continuum (see previous references). For nearly twenty years, researchers interested in butchery studies have used Binford’s (1978, 1981) observations among the Nunamiut, and sometimes their own observations, as a behavioural framework for interpreting cut marks on bones from various archaeological sites (e.g., Binford 1981, 1984c, 1988; Bunn 1982b, 1983a, 1983b; Bunn & Blumenschine 1987; Bunn & Ezzo 1993; Bunn & Kroll 1986, 1988b; Cruz-Uribe & Klein 1994; Gifford 1981; Gifford-Gonzalez 1989a; Lupo 1994; Lyman 1994b; Milo 1994, 1998; Potts 1983; Selvaggio 1994, 1998; Shipman 1983, 1986a, 1986b; Thomas & Mayer 1983; Toth 1982; Villa et al. 1986).

In her interpretation of cut marked bones from Olduvai Bed I sites, Shipman (1986a, 1986b, 1988b) assumed, among other things, that cut marks located near joints represent disarticulation and that cut mark patterning observed on bones from a Neolithic site could be used as an analogue for interpreting cut marked bones from Olduvai. Shipman’s assumptions were criticised as poorly grounded and even refuted by ethnoarchaeological data in some instances (Bunn & Blumenschine 1987; Gifford-Gonzalez 1989c; Lyman 1987b). Lyman (1987a, 1994b) pointed out that the near joint category includes cuts resulting from disparate butchery activities including skinning, filleting, and disarticulation. The MRM study supports this notion and additionally, that filleting cuts also occur on epiphyses and sometimes on articular surfaces. Another example of using cut mark placement to interpret cut marked bones is Bunn & Kroll’s (1986, 1988b) study of the cut marked bones from FLK Zinjanthropus. This study is discussed in more detail in section 6.4, but here I reiterate that their interpretation of cut mark placement is based largely on Binford’s (1981) interpretative framework and to a lesser degree on Bunn’s personal butchery experience (1985).

The importance of distinguishing filleting from disarticulation according to cut mark placement is evidenced by the studies cited above, and there are more. Researchers have in part based their reconstructions of hunting and scavenging on the presence of cut marks
associated with filleting and disarticulation respectively (e.g., Binford 1981, 1984c, 1988; Bunn & Kroll 1986, 1988b; Milo 1994, 1998; Shipman 1986a). Generally, it is believed that cut marks resulting from filleting meaty axial and appendicular skeletal elements reflects hunting or active scavenging on the part of hominids (e.g., Bunn & Ezzo 1993; Bunn & Kroll 1986, 1988b; Milo 1994, 1998). In my view, since no unequivocal proof of hunting has yet been established (but see for example Milo 1994, 1998), filleting cut marks on meaty bones only provide evidence for early and/or full access to animal carcasses. On the other hand, certain disarticulation cut marks are generally thought to be associated with passive scavenging (e.g., Binford 1981, 1984c). In my view, disarticulation marks can be equated with late access to animal carcasses, provided that filleting marks are absent from meaty bones bearing disarticulation marks.

The above discussion demonstrates the importance of using cut mark placement to determine specific butchery activities and in turn to reconstruct butchery and carcass acquisition strategies. Although reconstructing butchery and carcass acquisition strategies can inform us on a wide range of behaviours, I focus here on issues concerning palaeoanthropology. The latter are important for evaluating hominid behaviour in the Upper Pleistocene and Plio-Pleistocene in terms of behavioural modernity and the evolution of social structures. Due to the importance of distinguishing filleting from disarticulation cut marks based on their anatomical placement and orientation, section 5.4 compares Binford’s observations made among the Nunamiut with results stemming from the MRM study.

Before making comparisons between the MRM study and Binford’s (1981) interpretative framework in section 5.4, I briefly discuss certain aspects of Binford’s methodology for documenting butchery and resultant cut marks, and for assigning behavioural correlates to certain cut marks in section 5.3.

5.3. BINFORD’S METHODOLOGY

Binford made detailed observations of 37 separate butchery episodes performed by Nunamiut (1978, 1981). Butchery was performed most commonly on caribou and moose, but butchery of mountain sheep and bear was also observed (Binford 1978, 1981). All butchery activities were conducted with metal tools including knives, hatchets, and axes. Binford also recorded the bones from some 400 separate butchery episodes, but he does not tell us which attributes of the bones (e.g., bone surface modifications) were recorded. Still photography
and written notes were used to record butchery activities (Binford 1978, 1981). In section 3.4 I discuss certain limitations of recording a dynamic process such as butchery with static media (also see Bartram 1993a: 58; Binford 1981: 127-128; Metcalfe 1990: 3; Nilssen 1994: 100). Because butchery happens fast, it is impossible to systematically and thoroughly photograph or note activities and areas impacted by the cutting tool with any accuracy. I propose that a great deal of information escapes a researcher recording dynamic processes without the aid of a dynamic documenting device (Nilssen 1994). In addition to his observations of Nunamiut butchery, Binford personally butchered thirteen animals under Nunamiut supervision using different tools and tactics. I have already mentioned the concern with analysts performing their own butchery (also see Haynes 1991).

Although Binford observed numerous butchering episodes, the resultant bones were not returned to a laboratory for detailed macro- and microscopic study of bone surfaces after the bones were cleaned (Binford 1981: 131-132). Apparently, bones resulting from Nunamiut butchery were examined for cut marks with the naked eye, and Binford does not tell us how many bones were in fact examined. I discussed the importance of detecting cut marks by thoroughly examining bone surfaces with the aid of microscopic magnification in section 3.6, and Milo has shown that numerous cut marks are not detected without the aid of microscopic magnification (1994, 1998; also see Blumenschine et al. 1996). In all likelihood, a significant number of cut marks from Nunamiut butchery were not detected by Binford because bone surfaces were not thoroughly examined with the aid of microscopic magnification. Because Binford does not tell us how many bones were examined for cut marks, it is not clear what the actual sample was that contributed to his tabulation of cut mark locations and their associated behavioural functions.

Butchery activities observed by Binford included several processes such as skinning, filleting, and disarticulation. During Binford’s observations of Nunamiut butchery, different butchery activities were not controlled and could not be isolated, and therefore, the cut marks resulting from disparate activities could not be distinguished or separated according to specific activities with any certainty (Binford 1988). Binford articulates this fact in the following paragraph.

Regarding Bunn and Kroll’s (1986) contention that he avoided discussing the cut marks when interpreting the bones from FLK Zinjanthropus, Binford states that "I avoided discussing the cut mark data because I did not know of any reliable control data that could be used to guide their interpretation. Cut marks occur on bones as a result of sequential and
independent acts of processing. When we summarise archaeological cut marks we are producing a composite description of the results of potentially different and independently varying steps in the processing of animal products. I still know of only one control case (Binford 1984:73). To my knowledge, we have not a single body of cut mark data on modern bones for which the causal behavioural conditions are known. In my ethnographic data the cut marks are still a consequence of several processing steps and distinguishing one from another a matter of inference [my emphasis]" (Binford 1988:134). Over and above the fact that all bones from Nunamiut butchery were not thoroughly examined for cut marks, Binford makes it clear in the above citation that his tabulation of cut marks and their associated behavioural correlates is dubious because the cut marks represent palimpsests of activities which can not be separated. The marks he observed were palimpsests from various stages of butchery and could therefore not be unambiguously divided into filleting or dismemberment marks. Binford inferred cut mark functions. This alone demonstrates that Binford’s behavioural correlates for cut marks at specific anatomical locations and with particular orientations are dubious (1981: 136-142). In section 5.4 I demonstrate that many of Binford’s cut mark codes with allegedly unambiguous behavioural correlates are invalidated by observations made during the MRM study.

In addition to the above-mentioned inadequacies in Binford’s methodology for constructing his interpretative framework, certain contextual issues warrant brief mention. Some researchers have argued that Binford’s observations of Nunamiut butchery are not applicable to all archaeological sites, particularly in African contexts because; 1) Nunamiut usually butchered frozen carcasses while butchers in warmer climates like Africa do not generally process frozen carcasses, although, animals in rigor mortis are probably dealt with quite often (see discussion below), 2) Nunamiut often butchered more than one animal at a time, while ethnographic observations indicate that, like other aboriginal peoples, African butchers more commonly process single carcasses, 3) spoilage of meat is not an issue in Alaska, but certainly a concern in warmer climates, 4) the diversity of predators and carnivores are not as great a threat with respect to the loss of carcass parts due to scavenging in Alaska as is the case in the African context, and 5) Nunamiut commonly store animal products for future consumption while modern hunter-gatherers typically consume animal products shortly after acquisition, although meat is often dried for preservation and/or for short term delay in consumption (e.g., Bartram 1993a; Bunn & Kroll 1988b; Gifford-

Numerous authors, including Binford, have noted the paucity of problem oriented actualistic butchery studies and have stressed the importance of and need for additional actualistic research into the effects of butchery, specifically regarding the anatomical placement and frequencies of cut marks produced by disparate butchery activities (e.g., Binford 1988; Fisher 1995; Gifford-Gonzalez 1989a; Lyman 1994b; Milo 1994, 1998; Yellen 1977b). Although numerous actualistic butcheries were documented (see references cited in section 5.1), not one study circumvented the dilemma of disentangling the palimpsest of cut marks produced by multiple and disparate butchery activities. Therefore, Binford’s tabulation of cut marks and their associated behavioural correlates was not challenged or modified till now (1981, Table 4.04). Actualistic butchery observations at MRM were designed and undertaken to remedy some of the above-mentioned shortcomings in Binford’s framework, and to offer a new and updated analogue for interpreting cut mark placement, orientation, and frequencies. I stress that the MRM data should not be viewed as the “Rosetta Stone” for interpreting cut marks, but rather as a guide to the kind of cut mark patterning that may be expected if butchers had full, uninterrupted access to carcasses, disarticulated fully fleshed elements, filleted uncooked elements, and processed elements equally and thoroughly. If cut mark patterning in a zooarchaeological assemblage deviates from patterns observed in the MRM cut mark data, then researchers may formulate hypotheses of butchery and carcass acquisition strategies based on differences between the actualistic and archaeological assemblages (see for example sections 6.3, 6.4, and 6.5). On the other hand, if cut mark patterning in a zooarchaeological assemblage resembles that documented at MRM, a strong argument can be made for hominids butchering animals in similar ways and/or gaining similar access to animal carcass parts as butchers at MRM (see sections 6.3, 6.4, and 6.5).

The following methodological standards were incorporated into the design of the MRM study. 1) Butchery activities, specifically filleting exclusively and filleting and disarticulation, were isolated to avoid the quandary of palimpsests of cut marks resulting from disparate butchery activities (most animal carcasses were filleted exclusively, while some were filleted and disarticulated). Therefore, cut marks resulting from filleting exclusively were unequivocally distinguished from those resulting from filleting and disarticulation (see section 4.5.2). 2) Single carcasses were butchered in an unfrozen condition, although many animals were in rigor mortis when butchered (see Lupo 1994). In
my opinion, carcasses in rigor mortis can not be equated with frozen carcasses in terms of butchery strategies and resultant cut marks. Frozen meat and joints are not pliable and can not be manipulated, while meat and joints of a carcass in rigor mortis are certainly malleable (personal observations). In fact, during the MRM study I witnessed a few instances where carcasses were hung for two to three days to allow the muscles to relax and soften before butchery commenced. 3) Butchery activities were recorded with a dynamic documenting device (video) and could therefore be reviewed in detail numerous times to determine the impact of butchery tools at specific anatomical locations. 4) All bone surfaces were thoroughly examined for cut marks with the aid of a binocular microscope and low incidence light. To the best of my knowledge, the MRM study is the first problem oriented actualistic butchery study where disparate butchery activities were controlled and separable, and where butchery activities were filmed, facilitating detailed revision of activities after the fact (Nilssen 1994). For more detail on the methodology employed during the MRM study see chapter 3 and section 4.5.2. For the above reasons, I propose that behavioural correlates attributed to cut mark placement and orientation in section 5.4 are more realistic than those presented by Binford (1981). Moreover, cut marks are presented here that were not recorded and/or presented by Binford (1978, 1981). Additional problem oriented actualistic butchery studies are required to challenge or substantiate behavioural correlates attributed to certain cut marks below and in section 4.5.2.

5.4. THE ANATOMICAL PLACEMENT OF CUT MARKS AND THEIR BEHAVIOURAL CORRELATES

Here I compare results from the MRM study with Binford’s observations of Nunamiut butchery (1981), specifically with respect to cut mark placement, orientation, and their behavioural meaning. Some of Binford’s behavioural correlates are disproved, some are verified, and new cut mark codes with unambiguous and ambiguous behavioural correlates are presented. In section 4.5.2 cut marks with unambiguous behavioural correlates are presented (Table 4.37). In the same section I explained why and how I was able to attribute unambiguous functions to certain marks and why I am confident that my associations between cut marks and behavioural functions are more realistic than Binford’s (1981, Table 4.04). While only cut mark codes with unambiguous behavioural correlates are presented in Table 4.37, Table 5.1 includes all cut mark codes recorded by Binford and the present author,
apart from cut marks recorded by Binford that were not documented in the MRM study. New cut mark codes, followed by (PJN), with ambiguous behavioural correlates are also included in Table 5.1. Cut mark codes in Table 5.1 are based on Table 4.04 in Binford (1981: 136-141), but additional codes were added if he had none, or when the MRM observations and data motivated me to assign behavioural correlates different from those presented by Binford. Where necessary, Binford’s ‘part and description’ column was modified to accommodate the MRM data. Figures 4.236 to 4.279 display the anatomical placement and orientation of cut marks produced by various butchery activities during the MRM study. The construction of these figures is described in sections 3.9 and 4.5.2.

Because axial elements do not generally preserve as well as appendicular elements in archaeological sites (e.g., Blumenschine & Marean 1993; Brain 1981; Grayson 1989; Lam 1992; Lam et al. 1998; Lyman 1984, 1985; Marean et al. 1992; Woodborne 1996 and references therein), cut marks on axial elements are only discussed if they are of particular importance. In this study, scapulae and pelves are regarded as limb bones and are included with appendicular elements. The reader can examine Tables 4.37 and 5.1 as well as the above-mentioned figures in more detail for cut marks s/he is specifically interested in. As is evident in Table 5.1, many cut marks can not be attributed to a single activity because different butchery procedures do sometimes produce similar cut marks at identical anatomical locations. Cut mark types are defined in section 3.6 and their graphic representations are displayed in Figure D.27. Cut mark types are not discussed in any detail here but will form the basis for future research into the interpretative potential of cut mark angulation (type) for identifying specific butchery activities, particularly where different butchery actions impact the same anatomical region. For more detailed descriptions of butchery activities and resultant cut marks the reader may see chapter 4 and Binford (1978, 1981). Here I focus specifically on Binford’s tabulation of cut marks and their associated behavioural correlates (1981, Table 4.04). Detailed comparisons are restricted to meaty bones of the appendicular skeleton (but for other elements see Tables 4.37 and 5.1), starting with the upper bones of the front limb including the scapula, humerus, and radio-ulna and ending with the upper bones of the rear limb including the pelvis, femur, and tibia. Special reference is made to specific cut marks on ribs, thoracic, and lumbar vertebrae that are undoubtedly associated with early if not full access to animal carcasses. The following discussion should be read along with examination of Tables 4.37 and 5.1, in which the reader will be directed to appropriate figures in chapter 4 of this dissertation and in Binford (1981). Binford also refers to other
publications where relevant cut marks are presented (1981, Table 4.04, pp. 136-141). The anatomical placement and orientation of cut marks are not described in the text below as these aspects are evident in pertinent figures listed in Tables 4.37 and 5.1.

5.4.1. Scapula

In the MRM study, disarticulating the front limb from the thorax produced no cut marks. Cut marks labeled S-1 and S-2, which Binford attributed to dismembering, were produced on scapulae in the MRM assemblage when bones were filleted exclusively, and when bones were filleted and disarticulated. Therefore, these cuts are ambiguous indicators of butchery activity and do not unambiguously indicate disarticulation. Cut marks labeled S-9 (PJN) and S-12 (PJN) were not recorded or presented by Binford, but are unambiguously associated with disarticulating the scapula from the humerus in the MRM assemblage (Table 4.37).

Cut marks labeled S-3 and S-4 were exclusively produced during filleting. Binford suggests that these marks lend “strong support to the relationship suggested by this type of cut mark and the drying of meat” (1981: 98). Thomas and Mayer (1983) subsequently applied this interpretation. While cuts labeled S-3 and S-4 certainly provide evidence for filleting scapulae, they do not indicate how meat was subsequently prepared for consumption. Binford presents an accommodating argument, and all possible scenarios were not considered (1981: 98). For example, it is possible that meat was removed in preparation for cooking, or filleted after cooking. Either way, filleting this element may result in similar cut mark patterning regardless of how the meat was prepared for consumption after filleting. Gifford-Gonzalez (1993) noted that the roasting and boiling of meat on the bone has been recorded in several ethnographic contexts (e.g., Catlin 1959; Wissler 1910). However, if meat was roasted or boiled on the bone prior to filleting, different cut mark patterning may be expected than that recorded for filleting raw meat (e.g., Binford 1981; Bunn 1983a; Bunn et al. 1988; Gifford-Gonzalez 1989a, 1993; Kent 1993; Oliver 1993; Yellen 1977b, 1991a). The affects of cooking on cut mark patterning can only be resolved through additional problem oriented actualistic butchery studies. However, preliminary observations made during the MRM study suggest that roasting over coals causes meat to dry, toughen, and shrink, and meat tends to adhere firmly to bone surfaces. Therefore, the amount of effort (time and cutting strokes) required for filleting roasted meat may be similar to filleting raw meat, or a bit more effort may be required to fillet roasted meat. On the other hand, boiling undoubtedly softens meat...
and loosens it from the bone, making it easier to fillet. In fact, after prolonged boiling, meat is readily removed from bones without any cutting (personal observations). Edible tissues at certain parts of the anatomy are sinuous and very tough to chew unless they are boiled (e.g., meat around distal femur and proximal tibia, meat around distal humerus and proximal radius-ulna). We may expect that more cut marks are produced when filleting roasted meat than when filleting boiled meat. Since boiling technology was apparently not available in the Plio-Pleistocene and Upper Pleistocene, this culinary practice is not anticipated to affect cut mark patterning at sites occupied by hominids. Because boiling technology was available at Neolithic sites and probably not at Plio-Pleistocene or Upper Pleistocene sites, I caution against direct comparisons of cut mark data between Neolithic and Plio-Pleistocene or Upper Pleistocene sites without explicit consideration of the possible effects of culinary technology on cut mark patterning (e.g., Bunn & Kroll 1988b; Marshall 1986).

In the MRM study, meat from scapulae was never dried for biltong since it was considered too sinuous and was used instead for making sausage, as chops for grilling and braaing, and for stews. Filleting marks on scapulae do not inform about methods of preparing meat for consumption. Cut marks labeled S-3 and S-4 only indicate that scapulae were filleted. Additional cut marks labeled S-5 (PJN), S-6 (PJN), S-7 (PJN), S-8 (PJN), and S-11 (PJN) were not recorded and/or presented by Binford and are unambiguously linked to filleting (Table 4.37). Cut marks labeled S-10 (PJN) were produced when bones were filleted exclusively and when bones were filleted and disarticulated (Table 5.1). Therefore, these cuts can not be attributed to a single activity.

5.4.2. Humerus

All cut marks on the proximal humerus that Binford attributed to dismembering (Hp-1, Hp-2, and Hp-3) are equivocal indicators of disarticulation. In the MRM study, these cuts were produced during filleting exclusively as well as filleting and disarticulation. In fact, cuts labeled Hp-2 were made during filleting exclusively and video footage reveals that the butchery tool did not impact this location when scapulae were disarticulated from humeri. Therefore, in light of the MRM study, cuts labeled Hp-2 are unambiguously associated with filleting. Five new cut mark codes, not recorded and/or tabulated by Binford, are presented in Table 4.37 and are unambiguously associated with disarticulating the scapula from the humerus.
Cut marks labeled Hd-1 and Hd-4 were attributed to dismembering by Binford, and the MRM data corroborates this behavioural correlate. However, cut marks labeled Hd-2 and Hd-3, which Binford also linked to dismemberment, were produced by filleting exclusively and filleting and disarticulation in the MRM study. Consequently, these cuts are not unambiguous indicators of disarticulating humeri from radio-ulnae. This discovery is particularly important regarding cuts labeled Hd-3 because this cut mark code, among a few others, was used as an indicator of hominid scavenging behaviour. Binford’s (1981; 1984c) interpretation of these marks, particularly Hd-3, as indicating that hominids were marginal scavengers of stiff and desiccated carcasses is refuted by the MRM study. Lupo (1994) has shown that these marks are produced when animals in a state of rigor mortis are butchered. However, Lupo still regards these as disarticulation marks, but she demonstrates that similar marks are produced when early access to animals is not in doubt, and therefore, these marks are not reliable indicators of carcass acquisition (1994). The MRM data unequivocally demonstrate that cut marks labeled Hd-3 do not provide evidence for disarticulation at all, because they occur when animals are filleted exclusively. It follows that Hd-3 cuts do not inform about a specific butchery activity, and therefore can not provide evidence for carcass acquisition strategies and hominid behaviour. In light of the MRM study, two new cut mark codes are presented in Table 4.37, which are unambiguously associated with disarticulating humeri from radio-ulnae.

All Binford’s cut mark codes representing filleting of the humerus were recorded in the MRM assemblage (Table 5.1), and new cut mark codes resulting from the MRM study that are unambiguously linked to filleting humeri are presented in Table 4.37.

5.4.3. Radio-ulna

Two cut mark codes labeled RCp-2 and RCp-3 and attributed to dismembering by Binford are unambiguously assigned to filleting according to the MRM study. These marks were regularly produced by filleting the distal humerus and olecranon region, and were never made while disarticulating humeri from radio-ulnae during butchery at MRM. Binford’s dismemberment marks labeled RCp-4 and RCp-5 are verified by the MRM data. The reader will note that RCp-5 is included in cut marks labeled RCp-8 (PJN) in Table 5.1 because I have defined a more specific anatomical placement for RCp-5 than presented by Binford. Cut marks labeled RCp-8, apart from the more specific location of RCp-5, can not be attributed to
a single butchery activity. Two additional cut mark codes labeled RCp-13 (PJN) and RCp-17 (PJN) are unambiguously linked to disarticulating humeri from radio-ulnae. Binford’s cut marks labeled RCd-2 and attributed by him to dismemberment of radio-ulnae from metacarpals is supported by the MRM data.

Both Binford’s cut mark codes associated with filleting radio-ulnae, namely RCp-6 and RCp-7, are verified by the MRM study and additional cut mark codes undoubtedly linked to filleting are presented in Table 4.37. Based on the MRM assemblage, three new cut mark codes are presented in Table 5.1 that are associated with either skinning and/or filleting. These cuts can not be attributed to a single butchery activity at present. However, future analysis of cut mark angulation (type) using ArcView (GIS) and examined in association with butchery footage may shed additional light on distinguishing marks resulting from skinning from those produced during filleting. Provisionally, it appears that transverse cuts circling the distal portion of the radio-ulna shaft, which were made more or less perpendicular to the bone surface, are more likely produced by skinning while cuts made with the cutting edge at an angle with the bone surface are more likely the result of filleting. This hypothesis will be challenged or verified by more detailed analysis as outlined above.

5.4.4. Pelvis

The only cut marks unambiguously associated with disarticulating femora from pelves are labeled PS-2. Cut marks labeled PS-8 and PS-10, which Binford linked to dismemberment of the femur, are unambiguously linked to filleting according to the MRM study. Splitting the pelvis into two halves resulted in cut marks labeled PS-5 in the MRM assemblage. Binford also linked these cuts to dismemberment. An additional cut mark code linked to disarticulating the pelvis from the sacrum is labeled PS-13 (PJN). New cut mark codes presented in Table 5.1 can not be attributed to single butchery activities.

Binford presented one cut mark code, also recorded in the MRM assemblage, which is undoubtedly associated with filleting the pelvis and is labeled PS-3. Additional cut mark codes, not recorded or presented by Binford and that are unequivocally linked to filleting according to the MRM study are presented in Table 4.37.
5.4.5. Femur

Only one cut mark code (Fp-2) presented by Binford and attributed to dismembering the femur from the pelvis is verified by the MRM study. Cut marks labeled Fp-1, Fp-3, and Fp-5 were also attributed to dismemberment by Binford, but according to the MRM observations, these marks can not be attributed to a single activity as they were produced during filleting exclusively as well as filleting and disarticulation. New cut mark codes labeled Fp-12 (PJN) and Fp-13 (PJN), based on the MRM study, are unequivocally attributed to disarticulating femora from pelves. Regarding the disarticulation of femora from tibiae, only cut marks labeled Fd-3 by Binford were also unambiguously linked to disarticulation according to the MRM data. Cut marks labeled Fd-1 and Fd-2 that were linked to dismemberment by Binford were proved ambiguous indicators of single butchery activities in the MRM study. New cut mark codes undoubtedly linked to disarticulation of femora from tibiae are labeled Fd-7 (PJN) and Fd-8 (PJN). Additional cut marks that are ambiguous indicators of specific butchery activities are presented in Table 5.1.

All Binford’s cut mark codes attributed to filleting were verified by the MRM study, but three additional and unequivocal filleting cut mark codes are presented in Table 4.37.

5.4.6. Tibia

Apart from one, all cut mark codes presented by Binford are substantiated through the MRM study. Cut marks labeled Td-1 that were attributed by Binford to dismembering, are linked to either skinning and/or filleting according to the MRM study. An additional and unambiguous indicator of disarticulating tibiae from femora is cut mark code Tp-6 (PJN). Cut marks labeled Td-5 (PJN) can not be attributed to a single butchery activity.

5.4.7. Thoracic and Lumbar Vertebrae

Here I only refer to specific cut marks, but the reader can make additional comparisons by examining Tables 4.37 and 5.1 as well as the relevant figures referred to in these tables. Cut marks not recorded and/or presented by Binford, or anyone else to my knowledge, are labeled TV-6 (PJN) (thoracic vertebrae) and LV-7 (PJN) (lumbar vertebrae). Cuts labeled TV-6 (PJN) are located on the ventral inferior surfaces of thoracic vertebral centra, away from the articular surfaces of centra (Figures 4.244 and 4.245). These cuts are oriented
diagonally and transversely with respect to the long axis of the axial skeleton and were made with the cutting edge of the butchery tool at various angles with the bone surface. No meat is associated with the ventral surfaces of thoracic vertebrae. The only soft tissues that adhere to thoracic vertebrae are viscera. I have already described the locations where filleting marks and marks resulting from disarticulating ribs may overlap with evisceration marks. Therefore, cut marks labeled TV-6 (PJN) are unequivocally attributed to evisceration and can not be associated with any other butchery activity. The great value of these marks as indicators of carcass acquisition strategies practiced by people and hominids lies in the fact that viscera are consumed early in the carnivore flesh consumption sequence (Blumenschine 1986a). Consequently, the presence of indisputable evisceration marks on thoracic vertebrae from early archaeological sites very strongly indicates that hominids gained access to animal carcasses before non-hominid carnivores consumed a significant quantity of meat. The absence of evisceration marks on thoracic vertebrae may suggest that hominids did not gain early access to viscera or other parts consumed early in the carnivore consumption sequence. However, evisceration marks can not be viewed in isolation, but rather in tandem with other cut mark placements and frequencies that are reliable indicators of carcass acquisition strategies (see sections 6.3, 6.4, and 6.5).

Evisceration cut marks on lumbar vertebrae, labeled LV-7 (PJN), are more difficult to distinguish from filleting cuts than evisceration cuts on thoracic vertebrae, because muscles (the tenderloins11) are attached to the ventral surfaces of the lumbar transverse processes as well as the lateral surfaces of lumbar centra. Therefore, the precise location and orientation of cut marks are important to distinguish evisceration marks on lumbar vertebrae from those produced by removing the tenderloins (Figure 4.250). Like evisceration marks on thoracic vertebrae, but provided that these marks are accurately identified as unambiguous evisceration marks on lumbar vertebrae, they were not recorded by Binford and are strong indicators of early access to animal carcasses. The presence of cuts labeled LV-7 (PJN) indicate that people or hominids gained access to carcasses before substantial quantities of meat was consumed by non-hominid carnivores. As mentioned above, evisceration cuts should be considered along with other cut mark data that are reliable indicators of carcass

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11 The muscles Binford (1981) refers to as tenderloins are called sirloins in the MRM study and the tenderloin lies against the ventral surfaces of the transverse processes of the lumbar vertebrae and lateral surfaces of lumbar centra, stretching from the sacrum to about the last thoracic vertebra.
acquisition strategies. To the best of my knowledge, this is the first study that has revealed the presence and significance of evisceration marks on thoracic and lumbar vertebrae.

5.4.8. Ribs

Here I only discuss specific cut marks on ribs, but the reader can examine Tables 4.37 and 5.1 as well as the relevant figures referred to in the tables for additional information. Cut marks are commonly produced on and near rib heads and proximal rib shafts as a result of evisceration, filleting, and disarticulation. Therefore, cuts in these areas cannot be associated with single activities, but see the above-mentioned tables and figures for exceptions. Cut marks labeled RS-5 (PJN) were not recorded and/or presented by Binford, and to the best of my knowledge have not been presented or referred to by other researchers. These cuts are unequivocally linked to the removal of viscera because no meat is associated with the medial surfaces of rib shafts. The following characteristics are important criteria for accurately identifying cuts on medial surfaces of rib shafts as evisceration marks (Figures 4.276 and 4.278). 1) Cuts must be oriented transversely to diagonally with respect to the long axis of the rib shaft. However, provided that cuts are in the middle of the medial rib shaft, in other words not near the anterior or posterior edges, evisceration cuts may sometimes be longitudinal. Usually they are oriented transversely to diagonally. 2) Cuts must be outside the zone near the proximal end where they might overlap with cut marks resulting from filleting and/or disarticulation. In other words, they should be toward the distal part of the proximal rib shaft portion and distal of that portion. Evisceration cut marks are most numerous on the distal rib shaft portion in the MRM assemblage. 3) Cuts are predominantly made with the cutting edge of the butchery tool held either perpendicular or at an angle with the bone surface. Therefore cuts should consist predominantly of cuts and slices with some shave/cuts present\(^{12}\). Shave marks produced by evisceration are rare and I propose that shave marks are not necessarily unequivocal indicators of evisceration. 4) Cuts should occur either singularly or in clusters of very few marks (2 to 5 cut marks). Not all ribs retain evisceration marks (approximately 20% of small bovid ribs and 30% of large bovid ribs) and each rib retains only a few evisceration cut marks. Large numbers of cut marks on medial rib shafts may indicate that the rib slab was used as a cutting board for reducing larger pieces of meat into smaller portions or strips for drying, or in preparation for cooking. During the MRM study this practice was observed on a
few occasions, however, the lateral surfaces of rib slabs were always used as the cutting board surface.

Since viscera are among the first animal tissues consumed by non-hominid carnivores (e.g., Blumenschine 1985, 1986a, 1988a; Blumenschine & Marean 1993; Bunn & Ezzo 1993; Cavallo & Blumenschine 1989; Kruuk 1972; Schaller 1972), evisceration cut marks on ribs are argued here to be important and reliable indicators of early access to animal carcasses. The presence of evisceration cut marks on ribs in an early archaeological assemblage would strongly indicate that hominids gained access to animal carcasses before non-hominid carnivores consumed substantial quantities of meat. I discuss the problem concerning unequivocal proof of hunting in the archaeological record in section 6.3. I believe that the successful acquisition of animal products, either through hunting or scavenging is an important behavioural adaptation in hominid subsistence.

The ability of analysts to reliably identify the kind of access hominids gained to animal carcasses is critical to evaluate social behaviour of hominids and the emergence of behavioural modernity. Evisceration cut marks on ribs deposited by hominids would strongly suggest that they were successfully gaining access to animal carcasses before non-hominid carnivores consumed a significant quantity of meat.

Evisceration cut marks are not reported from FLK *Zinjanthropus*, and it is important to establish whether any such cuts are present at that site or not. However, Milo recorded numerous cut marks on medial surfaces of rib shafts from the site of Klasies River Mouth, South Africa (personal communication). Along with other data presented in sections 6.3 and 6.5, this strongly supports the notion that hominids at Klasies River Mouth were practicing a subsistence strategy consistent with at least one aspect of modern behaviour while hominids at FLK *Zinjanthropus* were apparently not.

The discovery of evisceration marks has major implications for reconstructing hominid behaviour regarding early or late access to animal products. Cut marks labeled RS-5 (PJN) are unmistakably linked to evisceration (an indicator of relatively early access to animal carcasses), and to the best of my knowledge these cuts were not reported or recognized for their real significance till now.

\[12\] Descriptions of cut mark types are presented in chapter 3, section 3.6.
5.4.9. Summary

Apart from the important discovery of evisceration marks and their significance for establishing carcass acquisition strategies, the MRM study provides important additions and changes to Binford’s (1981) frame of reference for identifying butchery activities from the anatomical placement and orientation of cut marks. Clearly, results from the MRM study have significant implications for earlier interpretations of cut marked bones based on Binford’s frame of reference. These are briefly mentioned below in section 5.5.

As a result of the MRM study a total of 117 new cut mark codes are added to Binford’s framework, including 18 ambiguous and 99 unambiguous indicators of specific butchery activities (Tables 5.1 and 4.37 respectively). New cut mark codes with unequivocal behavioural correlates include 43 codes associated with disarticulation, 44 codes linked to filleting, 8 codes indicating skinning, and 4 codes representing evisceration. The MRM observations and results demonstrate that of all Binford’s disarticulation marks for all skeletal elements 46% are ambiguous, and that of Binford’s dismemberment marks on limb bones (excluding carpals, tarsals, and extremities) 62% are equivocal. While many of Binford’s cut mark codes allegedly associated with dismemberment are refuted by the MRM study, all Binford’s filleting marks are verified by the MRM study and additional unequivocal filleting cut mark codes are presented in Table 4.37. Concerning Binford’s dismemberment indicators, the findings of the MRM study have major implications for earlier interpretations of cut marked archaeological bones based on Binford’s behavioural correlates, specifically with respect to reconstructions of hominid behaviour.
Table 5.1. Inventory of butchery marks recorded by Binford (1981) and this author as well as newly coded marks (PJN) with dubious behavioural correlates. Binford’s code numbers are excluded in cases where similar butchery marks were not recorded in this study. Code numbers are from Binford (1981, Table 4.04, pp. 136-141). My initials follow additional codes. Binford’s ‘part and description’ column was altered where required.

<table>
<thead>
<tr>
<th>Code Number</th>
<th>Part and Description</th>
<th>Binford's Activity</th>
<th>Nilssen's Activity</th>
<th>Binford's Figure Number</th>
<th>Nilssen's Figure Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-1</td>
<td>Skull</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>transverse cuts on occipital condyles</td>
<td>dismembering</td>
<td>disarticulation</td>
<td>4.11</td>
<td>4.236 a, c</td>
</tr>
<tr>
<td>S-4</td>
<td>cuts at the base of horns</td>
<td>skinning</td>
<td>skinning</td>
<td>4.10; 4.11</td>
<td>4.236 b, c</td>
</tr>
<tr>
<td>S-6</td>
<td>longitudinal cuts on maxilla above the tooth row</td>
<td>dismembering</td>
<td>disarticulating mandible from skull</td>
<td>4.19</td>
<td>4.237 a, b</td>
</tr>
<tr>
<td>M-3</td>
<td>cuts on medial surface</td>
<td>dismembering</td>
<td>removing tongue</td>
<td>not shown</td>
<td>4.238 a</td>
</tr>
<tr>
<td>M-5</td>
<td>cuts on inferior surface of mandibular condyle</td>
<td>dismembering</td>
<td>disarticulating mandible from skull</td>
<td>not shown</td>
<td>4.238</td>
</tr>
<tr>
<td>CV-1</td>
<td>Cervical vertebrae</td>
<td>transverse cuts across the anterior ventral surface of atlas marks on centrum and ventral surfaces</td>
<td>dismembering</td>
<td>disarticulating skull</td>
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<tr>
<td>CV-10 (PJN)</td>
<td></td>
<td>none</td>
<td>filleting and/or evisceration</td>
<td>none</td>
<td>4.240 b; 4.241 a, b, d; 4.243 a</td>
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<tr>
<td>TV-2</td>
<td>Thoracic vertebrae</td>
<td>longitudinal and diagonal cuts on both sides of dorsal spine cuts on superior surfaces of centrum, ventral surfaces of articular and transverse processes, and rib facets</td>
<td>filleting</td>
<td>filleting sirloin</td>
<td>4.21</td>
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<tr>
<td>TV-9 (PJN)</td>
<td></td>
<td>dismembering</td>
<td>disarticulating ribs</td>
<td>4.21</td>
<td>4.246; 4.247; 4.248; 4.249</td>
</tr>
<tr>
<td>TV-5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S-1</td>
<td>Scapula</td>
<td>marks along inferior border of condyle and/or at origin of triceps brachia</td>
<td>dismembering</td>
<td>filleting and/or disarticulation</td>
<td>4.29</td>
</tr>
<tr>
<td>S-2</td>
<td>Scapula</td>
<td>marks along the neck of the Scapula</td>
<td>dismembering</td>
<td>filleting and/or disarticulation</td>
<td>4.29</td>
</tr>
<tr>
<td>S-3</td>
<td>longitudinal and diagonal marks along base of spine in both the the supra- and infraspinous fossae</td>
<td>filleting</td>
<td>filleting</td>
<td>4.06</td>
<td>4.254 b</td>
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<tr>
<td>S-4</td>
<td>Humerus</td>
<td>predominantly longitudinal and diagonal marks up and down the medial face of the scapula marks on medial and lateral edges of glenoid cavity</td>
<td>filleting</td>
<td>filleting</td>
<td>not shown 4.254 d</td>
</tr>
<tr>
<td>S-10 (PJN)</td>
<td></td>
<td>none</td>
<td>filleting and/or disarticulation</td>
<td>none</td>
<td>4.256</td>
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<td>Hp-1</td>
<td></td>
<td>marks along the border of the “lip” of ball, concentrated on the posterior edge</td>
<td>dismembering</td>
<td>filleting and/or disarticulation</td>
<td>4.30</td>
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<tr>
<td>Hp-2</td>
<td></td>
<td>marks on the apex of the lateral tuberosity</td>
<td>dismembering</td>
<td>filleting</td>
<td>4.30</td>
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</table>

(continued)
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<th>Binford's Figure Number</th>
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<tr>
<td>Hp-3</td>
<td>marks on the lateral face of the neck just below the lateral tuberosity</td>
<td>dismembering</td>
<td>filleting and/or disarticulation</td>
<td>4.30</td>
<td>4.257 c</td>
</tr>
<tr>
<td>Hp-4</td>
<td>short &quot;chevron&quot; marks obliquely oriented along crest below the external tuberosity at insertion of teres minor</td>
<td>filleting</td>
<td>filleting</td>
<td>4.39</td>
<td>4.257 c</td>
</tr>
<tr>
<td>Hp-5</td>
<td>short &quot;chevron&quot; marks obliquely oriented on medial face below the head</td>
<td>filleting</td>
<td>filleting</td>
<td>4.39</td>
<td>4.257 a</td>
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<tr>
<td>Hd-1</td>
<td>transverse cuts on distal articulation surface of medial condyle</td>
<td>dismembering</td>
<td>disarticulation</td>
<td>4.30</td>
<td>4.258 b</td>
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<tr>
<td>Hd-2</td>
<td>transverse marks across medial face</td>
<td>dismembering</td>
<td>filleting and/or disarticulation</td>
<td>4.15; 4.30</td>
<td>4.257 a, b, c; 4.258 a, b</td>
</tr>
<tr>
<td>Hd-3</td>
<td>marks on the margins of the olecranon fossa (stiff body)</td>
<td>dismembering</td>
<td>filleting and/or disarticulation</td>
<td>4.30; 4.31</td>
<td>4.257 c, d; 4.258 c, d</td>
</tr>
<tr>
<td>Hd-4</td>
<td>diagonal and transverse cuts on lateral edge and articular surface of lateral condyle</td>
<td>dismembering</td>
<td>disarticulation</td>
<td>4.30</td>
<td>4.258 b, c</td>
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<tr>
<td>Hd-6</td>
<td>oblique short &quot;chevron&quot; marks clustered on neck of distal end on the anterior face</td>
<td>filleting</td>
<td>filleting</td>
<td>4.39</td>
<td>4.257 b</td>
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<tr>
<td>Hd-7</td>
<td>longitudinal marks along medial crest of shaft</td>
<td>filleting</td>
<td>filleting</td>
<td>4.39</td>
<td>4.257 a</td>
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</table>

**Radio-ulna**

| RCp-2 | diagonal marks across lateral surface of olecranon | dismembering | filleting | 4.32 | 4.259 c |
| RCp-3 | diagonal marks across medial face of olecranon | dismembering | filleting | 4.32 | 4.259 a |
| RCp-4 | marks on upper margin of medial side of semilunar notch | dismembering | disarticulation | 4.32 | 4.260 a |
| RCp-5 | transverse marks on medial, lateral, and anterior margin of radial tuberosities and on anconeal process | dismembering | disarticulation | 4.31; 4.32 | 4.260 a, b, c; 4.261 a |
| RCp-6 | clustered oblique "chevron" marks below lateral and medial tuberosities of radius | filleting | filleting | 4.39 | 4.259 a, b, c |
| RCp-7 | longitudinal and diagonal marks along medial and lateral surfaces of ulna shaft | filleting | filleting | 4.39 | 4.259 a, c |
| RCp-8 (PJN) (includes RCp-5) | transverse and diagonal marks on medial side of radial tuberosity just below articular condyle | dismembering | filleting and/or disarticulation | 4.31; 4.32 | 4.259 b; 4.260 b |
| RCp-14 (PJN) | transverse and diagonal marks on posterior border of ulna shaft | none | skinning and/or filleting | none | 4.259 d |
| RCp-16 (PJN) | marks on proximal surface of olecranon | none | skinning and/or filleting | none | 4.259 a |
| RCs-2 (PJN) | marks on middle and distal shaft of ulna shaft | none | skinning and/or Filleting | none | 4.259 |

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<tr>
<td>RCd-2</td>
<td>transverse marks across the styloid process and marks on articular surface of styloid process</td>
<td>dismembering</td>
<td>disarticulation</td>
<td>4.32</td>
<td>4.261 b</td>
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<tr>
<td>C-1</td>
<td>transverse cut along articular margin of cuneiform</td>
<td>dismembering</td>
<td>disarticulation</td>
<td>not shown</td>
<td>4.262 b</td>
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<tr>
<td>PS-2</td>
<td>marks inside the acetabulum</td>
<td>dismembering</td>
<td>disarticulation</td>
<td>not shown</td>
<td>4.266 a</td>
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<tr>
<td>PS-3</td>
<td>marks across the lateral face of pubis</td>
<td>filleting</td>
<td>filleting</td>
<td>4.36</td>
<td>4.265 a</td>
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<tr>
<td>PS-5</td>
<td>cut or chop through the pubic symphysis</td>
<td>dismembering</td>
<td>splitting pelvis into two halves</td>
<td>4.36</td>
<td>4.264 a, c (not shown)</td>
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<td>PS-8</td>
<td>marks below acetabulum on arm of ischium</td>
<td>dismembering</td>
<td>filleting</td>
<td>4.22; 4.24</td>
<td>4.265 b</td>
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<td>PS-10</td>
<td>marks below acetabulum on arm of pelvis</td>
<td>dismembering</td>
<td>filleting</td>
<td>4.20; 4.22; 4.265 a, b</td>
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<tr>
<td>PS-11 (PJN)</td>
<td>marks on medial side of ventral border of ilium shaft adjacent to sacro-iliac joint</td>
<td>none</td>
<td>filleting and/or disarticulating pelvis from sacrum</td>
<td>4.24</td>
<td>none</td>
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<tr>
<td>PS-12 (PJN)</td>
<td>marks on dorsal border of ilium shaft adjacent to sacro-iliac joint</td>
<td>none</td>
<td>filleting and/or disarticulating pelvis from sacrum</td>
<td>none</td>
<td>none</td>
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<tr>
<td>PS-14 (PJN)</td>
<td>marks on medial surface of ilium shaft in vicinity of sacro-iliac joint</td>
<td>none</td>
<td>filleting and/or disarticulating pelvis from sacrum</td>
<td>none</td>
<td>none</td>
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<tr>
<td>PS-18 (PJN)</td>
<td>marks on articular ridges of acetabulum</td>
<td>none</td>
<td>filleting and/or disarticulation</td>
<td>none</td>
<td>none</td>
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<tr>
<td>Fp-1</td>
<td>marks on the neck of the femur</td>
<td>dismembering</td>
<td>filleting and/or disarticulation</td>
<td>4.25</td>
<td>4.267 a, b, d; 4.268 d; 4.269 a, b, d; 4.270 d</td>
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<tr>
<td>Fp-2</td>
<td>marks on the ball of femur head across fovea capitis</td>
<td>dismembering</td>
<td>disarticulation</td>
<td>4.25</td>
<td>4.269 a, d; 4.270 d</td>
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<tr>
<td>Fp-3</td>
<td>marks circling the margin of the femur head</td>
<td>dismembering</td>
<td>filleting and/or disarticulation</td>
<td>4.25</td>
<td>4.267 a, b, d; 4.268 a, d; 4.269 a, d; 4.270 d</td>
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<tr>
<td>Fp-4</td>
<td>marks on trochanter minor transverse marks on lateral surface of trochanter major</td>
<td>filleting</td>
<td>filleting</td>
<td>4.25</td>
<td>4.267 a, d; 4.269 a, d</td>
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<tr>
<td>Fp-5</td>
<td>marks in the fossa along the neck of the femur</td>
<td>dismembering</td>
<td>filleting and/or disarticulation</td>
<td>4.25</td>
<td>4.267 a, d; 4.269 a, d</td>
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<tr>
<td>Fp-6</td>
<td>short marks on the neck of greater trochanter, anterior face</td>
<td>filleting</td>
<td>filleting</td>
<td>4.37</td>
<td>4.267 b</td>
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<tr>
<td>Fp-7</td>
<td>longitudinal marks on upper shaft of femur on anterior and lateral surface</td>
<td>filleting</td>
<td>filleting</td>
<td>4.37</td>
<td>4.267 b, c</td>
</tr>
<tr>
<td>Fp-10 (PJN)</td>
<td>longitudinal and diagonal marks on medial, lateral, posterior, and proximal surfaces of trochanter major</td>
<td>none</td>
<td>filleting and/or disarticulation</td>
<td>none</td>
<td>4.267 a, c, d; 4.268 a; 4.269 a, d; 4.270 a</td>
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<tr>
<td>Fp-15 (PJN)</td>
<td>marks on superior articular surface of head</td>
<td>none</td>
<td>filleting and/or disarticulation</td>
<td>none</td>
<td>4.268 a; 4.270 a</td>
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<tr>
<td>Fd-1</td>
<td>transverse marks across posterior surface on and just above condyles</td>
<td>dismembering</td>
<td>filleting and/or disarticulation</td>
<td>4.25</td>
<td>4.267 a, c, d; 4.268 b; 4.269 c, d; 4.270 b</td>
</tr>
<tr>
<td>Fd-2</td>
<td>nick marks on margins of trochlea</td>
<td>dismembering</td>
<td>filleting and/or disarticulation</td>
<td>4.25</td>
<td>4.267 a, b; 4.268 c; 4.270 c</td>
</tr>
<tr>
<td>Fd-3</td>
<td>diagonal marks on inferior surfaces of medial and lateral condyles</td>
<td>dismembering</td>
<td>disarticulation</td>
<td>4.25</td>
<td>4.270 c</td>
</tr>
<tr>
<td>Fd-4</td>
<td>diagonal marks on distal shaft on posterior face</td>
<td>filleting</td>
<td>filleting</td>
<td>4.38</td>
<td>4.267 d</td>
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<tr>
<td>Fd-5</td>
<td>diagonal mark on anterior face above trochlea</td>
<td>filleting</td>
<td>filleting</td>
<td>4.38</td>
<td>4.267 b, c</td>
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<tr>
<td>Fd-6 (PJN)</td>
<td>marks on medial and lateral sides of distal epiphysis and edges of articular surfaces</td>
<td>none</td>
<td>filleting and/or disarticulation</td>
<td>none</td>
<td>4.267a, c, d; 4.268 b, c; 4.270 c</td>
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**Tibia**

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<td>Tp-1</td>
<td>marks on or around intercondylar tubercles</td>
<td>dismembering</td>
<td>disarticulation</td>
<td>4.26</td>
<td>4.272 a, b; 4.273 a</td>
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<tr>
<td>Tp-2</td>
<td>transverse to diagonal marks across the posterior face of the lateral and medial condyles</td>
<td>dismembering</td>
<td>disarticulation</td>
<td>4.26</td>
<td>4.272 c, d</td>
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<tr>
<td>Tp-3</td>
<td>short oblique marks on the lateral face of the tibia crest</td>
<td>filleting</td>
<td>filleting</td>
<td>4.37</td>
<td>4.271 b, c</td>
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<tr>
<td>Tp-4</td>
<td>oblique marks on medial face just below the articular surface</td>
<td>filleting</td>
<td>filleting</td>
<td>4.37</td>
<td>4.271 a</td>
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<tr>
<td>Tp-5</td>
<td>longitudinal marks on the upper tibia shaft</td>
<td>filleting</td>
<td>filleting</td>
<td>4.37</td>
<td>4.271 a</td>
</tr>
<tr>
<td>Td-1</td>
<td>transverse marks across medial malleolus and just above on distal tibia</td>
<td>dismembering</td>
<td>skinning and/or filleting</td>
<td>4.26</td>
<td>4.271 a, c, d</td>
</tr>
<tr>
<td>Td-5 (PJN)</td>
<td>transverse to diagonal marks on distal shaft and epiphysis</td>
<td>none</td>
<td>skinning and/or filleting</td>
<td>none</td>
<td>4.271</td>
</tr>
<tr>
<td>Td-6 (PJN) (includes Td-4)</td>
<td>shave/cuts on medial and anterior surfaces of distal shaft and short cuts on anterior face</td>
<td>filleting</td>
<td>filleting</td>
<td>4.38</td>
<td>4.271 a, b</td>
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**Tarsals**

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<td>TA-1 (Astragalus)</td>
<td>transverse marks on anterior face, midway on the bone (Calcaneum) predominantly transverse marks on anterior and lateral surfaces, on distal quarter of bone</td>
<td>dismembering</td>
<td>disarticulation</td>
<td>4.27</td>
<td>4.274 b</td>
</tr>
<tr>
<td>TC-1</td>
<td>dismembering</td>
<td>disarticulation</td>
<td>4.274 b, c, d</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TC-3</td>
<td>(Calcaneum) marks on anterior surfaces in middle of bone (Calcaneum) shaves and shave/cuts on lateral surface, above articular region (Calcaneum) shaves and shave/cuts on superior, lateral, and posterior surfaces of tuber calcis</td>
<td>filleting, hanging carcass</td>
<td>filleting, hanging carcass</td>
<td>4.27</td>
<td>4.275 b, c</td>
</tr>
<tr>
<td>TC-5 (PJN)</td>
<td>skinning and/or filleting</td>
<td>skinning and/or filleting</td>
<td>4.275 c</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TC-6 (PJN)</td>
<td>none</td>
<td>skinning and/or filleting</td>
<td>none</td>
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<tbody>
<tr>
<td>TE-1</td>
<td>(External and middle cuneiform) transverse cut marks on medial, anterior, and posterior surfaces</td>
<td>dismembering</td>
<td>disarticulation</td>
<td>4.28</td>
<td>4.274 a, b, d</td>
</tr>
<tr>
<td>TNC-1</td>
<td>(Naviculo-cuboid) predominantly transverse cuts on all surfaces</td>
<td>dismembering</td>
<td>disarticulation</td>
<td>4.28</td>
<td>4.274</td>
</tr>
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<td>TLM-1 (PJN)</td>
<td>longitudinal mark on superior, anterior face of lateral malleolus</td>
<td>none</td>
<td>skinning and/or filleting</td>
<td>none</td>
<td>4.275 b, c</td>
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<tr>
<td>RS-1</td>
<td>marks along superior surface lateral to the rib head</td>
<td>filleting</td>
<td>filleting sirloin</td>
<td>not shown</td>
<td>4.277 b; 4.279 b</td>
</tr>
<tr>
<td>RS-3</td>
<td>transverse cut on ventral rib surface just to the side of the rib head</td>
<td>dismembering (ribs)</td>
<td>evisceration and/or filleting and/or disarticulating ribs</td>
<td>not shown</td>
<td>4.276 a; 4.278 a</td>
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5.5. RECONSTRUCTIONS OF BUTCHERY AND CARCASS ACQUISITION STRATEGIES BASED ON BINFORD’S FRAMEWORK

The importance and influence of Binford’s work among the Nunamiut on subsequent research into the identification and interpretation of hominid behavioural signatures represented in zooarchaeological assemblages can not be overstated. Without the stimulus injected by Binford’s research into establishing interpretative frameworks (‘middle-range theory’), a great deal of ethnographic and experimental work would still be lacking, including the information presented in this dissertation. The MRM study is a product directly attributable to Binford’s inspiration.

In section 5.2 I pointed out that numerous authors have interpreted cut mark placement and orientation based on Binford’s interpretative framework constructed according to his observations of animal butchery by the Nunamiut (see references cited in section 5.2). In the same section I described the importance of distinguishing accurately between cut marks produced by filleting and those made during disarticulation for reconstructing the nature of hominid access to animal carcasses or parts of carcasses. Establishing the nature of hominid carcass acquisition strategies has important implications for reconstructing hominid social behaviour and the emergence of behavioural modernity.
Problems with Binford’s methodology, in recording Nunamiut butchery activities and cut marks on bones resulting from said butchery, are discussed in section 5.3. Methodological constraints limit the merit of Binford’s interpretative framework. In section 5.3 I also discussed certain contextual issues and cautioned against the use of Binford’s framework in circumstantial and environmental conditions different from those prevailing in Alaska (also see references cited in section 5.3). Over and above these limitations, the discussions in section 5.4 demonstrate that 62% of Binford’s dismemberment marks on meaty appendicular limb bones are not unambiguous indicators of disarticulation. The MRM study has yielded many additional cut mark codes that are unambiguously associated with either filleting or disarticulation (Table 4.37). In light of the MRM data, interpretations of cut marks founded on Binford’s interpretative framework, and subsequent reconstructions of hominid behaviour based on those interpretations require serious reconsideration.

I propose that, because actualistic butchery at MRM was controlled and accurately recorded, and specific butchery activities (filleting versus disarticulation) could be separated with certainty, the cut mark codes and their behavioural correlates presented in Table 4.37 present an unprecedented interpretative framework for identifying butchery activities from cut mark placement and orientation. As mentioned above, the MRM data should not be viewed as the fingerprint directory of butchery, but rather as a guide to the cut mark patterning that can be expected when animals are acquired early and butchered (especially filleted) fully. This proposition is substantiated when the MRM data are compared with cut mark data from Klasies River Mouth and FLK Zinjanthropus in sections 6.3 and 6.4 respectively.

Numerous interpretations of cut marked bones from archaeological sites need to be re-evaluated in light of the MRM data and I do not offer such an investigation and discussion here. However, the interpretation of specific cut marks, for example cut marks labeled Hd-3, are discussed in section 5.4 and more detailed discussion of interpretations of cut marked bones from two important archaeological sites, that are based on Binford’s interpretative framework, are presented in sections 6.3 and 6.4. For more robust and realistic interpretations of cut mark data from archaeological sites, the anatomical placement and orientation of cut marks should be viewed in tandem with the proportional distribution of cut mark frequencies across different anatomical portions of the skeleton. In sections 6.3. and 6.4 I demonstrate that cut mark placement and their frequencies, when viewed in conjunction with the carnivore
consumption sequence and utility indices (Blumenschine 1986a; Blumenschine & Caro 1986), can be used to identify the nature of hominid involvement with animal carcasses.
CHAPTER 6

IMPLICATIONS FOR RECONSTRUCTING HOMINID STRATEGIES OF CARCASS ACQUISITION AND BUTCHERY IN THE UPPER PLEISTOCENE AND PLIO-PLEISTOCENE

6.1. INTRODUCTION

In this chapter I discuss issues enlightened by the MRM actualistic study that are pertinent to reconstructing carcass acquisition and butchery strategies practiced by hominids in the Upper Pleistocene and Plio-Pleistocene. With respect to resolving the hunting/scavenging debate, I highlight some methodological concerns about establishing early or late access to animal carcasses, specifically on grounds of anatomical placement of cut marks and cut mark frequencies. Some earlier interpretations of hominid butchery and carcass acquisition strategies in the Upper Pleistocene and Plio-Pleistocene are examined and critiqued, and additional and/or alternative explanations are offered based on observations made at MRM. I make a few suggestions to improve the recording, quantification, analysis, and interpretation of cut marks on animal bones. To improve our understanding of similarities and differences in butchery and carcass acquisition strategies across space and through time, cut mark data from archaeological assemblages must be comparable. Similarly, archaeological data must be comparable to actualistic data. It is critical, therefore, that analysts follow similar methodologies in recording cut marks and presenting cut mark data.

In section 6.2 I discuss the relationship between butchered bones and the frequency of bones retaining cut marks. The anatomical placement of cut marks and their function, and differences in cut mark frequencies between small and large bovids are briefly mentioned in parts of sections 6.3 and 6.4. With respect to reconstructing certain behaviours of hominids in the Upper Pleistocene and Plio-Pleistocene, sections 6.3 and 6.4 examine Milo’s (1994, 1998) and Bunn and Kroll’s (1986, 1988b) interpretations of cut marked bones from Klasies River Mouth (KRM1) (South Africa) and FLK Zinjanthropus (FLK) (Olduvai Gorge, Tanzania) respectively. I highlight and investigate specific methodological constraints in employing cut
mark placement and frequencies of cut marks for reconstructing butchery and carcass acquisition strategies. I make some suggestions to improve methods of quantification and interpretation, and offer additional and/or alternative interpretations of the cut mark data from KRM1 and FLK. Finally, a limited comparison is made between the cut mark information from KRM1 and FLK in section 6.5. Human ancestors depositing bones at these sites were apparently butchering and/or acquiring carcasses very differently.

6.2. BUTCHERED BONES AND THE FREQUENCY OF BUTCHERY-MARKED BONES

A major assumption necessary for studying and interpreting the frequencies of butchery marks is that a direct and positive relationship exists between the number of butchered bones and the number of butchered bones retaining butchery marks (Lyman 1992, 1994b). “If butchery marks are epiphenomena, that is, if they are in some sense an unintended, accidental, fortuitous, or incidental result of butchery activities, … [and] If the frequencies of butchery-marked bones are not positively correlated with the frequencies of butchered bones then frequencies of butchery-marked bones, either absolute or proportional, are potentially ambiguous indicators of the quantitative aspects of human butchering behaviors” (Lyman 1994b: 301-303). Lyman (1994b: 302-303) adds that because no research on this issue has yet been published, “analysts interested in analyzing and interpreting frequencies of butchery marks must make the assumption that the two variables are positively correlated.”

Lyman’s (1992, 1994b) argument regarding the accidental nature of butchery marks is well grounded since butchery involves the removal of tissues from bone and not the creation of butcher marks on bone surfaces. Nevertheless, results from the current study show a direct and positive correlation ($r^2 = 0.998$) between the number of butchered bones and the number of butchered bones retaining butchery marks (see Table 4.36). Based on this finding I propose that the frequencies of butchery-marked bones are not ambiguous indicators of the quantitative aspects of human butchering behaviours (*contra* Lyman 1994b: 301-303). Table 4.36 shows that the correlation between butchered bones and butchery-marked bones is marginally stronger for large relative to small bovids.

Although these results are persuasive, the reader is cautioned that animals in the MRM study were butchered predominantly with metal tools. Our current understanding of the variability in the frequencies of cut marks created by metal and stone tools does not permit
the assumption that frequencies of butchery marks as produced by different tools are directly comparable. Nevertheless, preliminary observations made here suggest that stone tools may produce higher frequencies of butchery marks since more cutting strokes are required during butchery performed with stone tools as opposed to metal ones. On a qualitative level, butchery footage from this study reveals that more time and effort were required to butcher with stone rather than metal tools. This preliminary observation requires further investigation and quantification.

An additional variable worthy of mention concerns access to animal carcasses. Binford (1988:127) has suggested that the frequencies of cut marks and their distribution on various bones “may reflect very different processing operations”. McHenry and O’Brien have stated the possibility that “the frequency and location of cut marks are the result of differential access to skeletal elements” (1986: 447). Discussions below show that the proportional distribution of cut marks at different anatomical portions of the skeleton are certainly indicative of different butchery processes and differential access to carcasses. Though not based on an actualistic sample, Binford (1988: 132) has already used a similar approach when he compared cut mark information from FLK with that from the sites of Petersfel and Bugasholding. In this comparison Binford used percentages of cut marked pieces to measure the amount of effort invested in butchery. This procedure is modified below and the MRM actualistic assemblage is used as the standard against which the Klasies River Mouth and FLK cut mark data are evaluated. Binford employed a similar approach, but an appropriate actualistic assemblage against which archaeological assemblages could be compared was not available at the time (Binford 1988: 134). The MRM data provide a frame of reference, where butchery procedures were controlled and carefully documented, for establishing the proportional distribution of cut mark frequencies where access to animal carcasses was not an issue, and where small and large animals were processed uniformly.

Digression from patterns observed in the MRM assemblage may be interpreted as differential access to different skeletal elements and/or differential butchery procedures. In the MRM study the butchers had early, complete, and uninterrupted access to carcasses. Consequently, besides metapodials and extremities, entire carcasses of small and large animals were butchered thoroughly. Where hunter-gatherers do not necessarily have early, complete, and uninterrupted access to carcasses, animals or body parts may or may not be butchered equally or completely. Consequently, proportional frequencies of cut marks and butchery marked bones, across different anatomical portions, may be a direct indicator of the
kind of access hominids had to animal carcasses. For example, if butchers had early, complete, and uninterrupted access to animal carcasses, then the proportional distribution of cut mark frequencies on different portions of a given skeletal element (% Mean Cut mark Frequency [% MCF] by skeletal element) as well as the proportions of cut mark frequencies at specific anatomical loci with respect to total cut mark frequencies (% MCF by anatomical locus of the total MCF) may be expected to follow a pattern similar to that observed in the MRM data. On the other hand, if the proportional distribution of cut mark frequencies on bones from an archaeological assemblage are markedly different from those tabulated during the MRM study, we can begin to formulate arguments about the kind of access occupants of that site had to animal carcasses.

The proportional distribution of cut mark frequencies across different anatomical portions should also be evaluated with respect to the carcass consumption sequence (e.g., Blumenschine 1986a) as well as utility indices (e.g., Binford 1978; Blumenschine & Caro 1986). For example, proportionately high frequencies of cut marks on elements ranking low in the carnivore consumption sequence, and on elements associated with small quantities of meat can be expected if access to animal carcasses was late (Binford 1984b, 1984c; Blumenschine 1986c). Conversely, proportionately high frequencies of cut marks on elements ranking high in the carnivore consumption sequence and on elements associated with large quantities of meat can be anticipated if access to carcasses was full or early. Of course, untangling taphonomic biases must precede and accompany analyses and interpretations of cut marked bones.

In summary, results from the MRM study show that, even though cut marks are accidental and fortuitous, they fortunately are created with such consistency that cut mark locations and frequencies must be weighed as critical quantitative features for reconstructing butchery and carcass acquisition behaviours practiced by hominids. This proposition is substantiated with data and results of statistical analyses of cut mark data from MRM, KRM1, and FLK presented in sections 6.3, 6.4, and 6.5.
6.3. MILO’S (1998) INTERPRETATION OF CUT MARKED BONES FROM CAVE 1 AT KLASIES RIVER MOUTH (KRM1), SOUTH AFRICA

6.3.1. Introduction

The site of Klasies River Mouth (KRM) has featured prominently in the literature on human evolution because it furnished the earliest anatomically near-modern hominid bones thus far unearthed (Brauer & Rimbach 1990; Deacon & Geleijnse 1988; Deacon et al. 1986; Grün et al. 1990; Milo 1994, 1998; Rightmire & Deacon 1991; Singer & Wymer 1982). Hominids at KRM continued the tradition of their ancestors in making Middle Stone Age (MSA) tools (Thackeray 1992) and it is debated that they lacked behavioural traits considered indicative of modern human behaviour (Binford 1981, 1984c; Blumenschine 1986a; Klein 1995; Klein & Cruz-Uribe 1996; but for opposing evidence see Deacon 1995; Henshilwood & Sealy 1997; Yellen et al. 1995).

Since the hominid remains from KRM are not quite anatomically modern, and dated to around 100 000 years ago (Deacon & Geleijnse 1988; Grün et al. 1990), the faunal remains from Cave 1 at Klasies River Mouth (KRM1) are suitably placed to test the theory that successful hunting or gaining early access to animal carcasses was a relatively recent behavioural trait in human evolution (e.g., Binford 1981, 1984c; Blumenschine 1986a; Klein 1995; Klein & Cruz-Uribe 1996; Marean 1989; Potts & Shipman 1981; Shipman 1986a). Considerable effort has been expended to determine carcass acquisition strategies practiced by hominids at KRM, and how these strategies compare with those practiced by anatomically and behaviourally modern Later Stone Age people (Binford 1984c; Klein 1976, 1992, 1995; Klein & Cruz-Uribe 1983, 1996; for more detail see Milo 1994, 1998). Regarding carcass acquisition strategies, Klein suggests that the species and age profiles of fauna from KRM indicate that hominids were not behaviourally modern in the same way as Later Stone Age (LSA) people (but see Marean 1998; Marean & Kim 1998).

Based largely on skeletal part profiles and bone surface modification, Binford (1984c) argued that hominids at KRM infrequently acquired small bovids and were marginal scavengers of large bovid carcasses. Milo (1994, 1998) highlights the principle weaknesses in Binford’s (1984c) methodology and interpretation. See the discussion in section 6.4.1 below concerning the limitations of age and skeletal part frequencies as well as Binford’s (1981) behavioural correlates for evaluating carcass acquisition strategies. As proposed in section 6.4.1, because of the perplexing effects of taphonomic processes, the anatomical placement...
and frequencies of cut marks are among the strongest lines of evidence for human involvement with animal carcasses (see references cited in section 6.4.1).

Below I focus on the most recent interpretations of cut marked bones from KRM1 presented by Milo (1994, 1998). His primary objective was to assess “the range of bovid products that hominids had access to and their means of acquiring them” (Milo 1998: 101). Although Milo examined bone surfaces for both butchery marks and carnivore tooth marks, I focus on his interpretations of the cut marks since the MRM data are not suitable for evaluating other bone surface modifications.

I start (section 6.3.2) with a discussion of certain methodologies employed and proposed by Milo (1998), particularly those tested and enhanced by the MRM study. With reference to these methods I make some suggestions for their use and improvement, and also recommend – in view of the MRM data - a revised method for determining carcass acquisition strategies. In section 6.3.3 I summarize and critique Milo’s interpretations and, where possible, additional and/or alternative explanations for the cut mark data from KRM1 are presented. My interpretations are based on comparing the KRM1 cut mark data with those from the MRM actualistic assemblage. In section 6.5 I also compare the KRM1 and FLK Zinjanthropus (FLK) cut mark data to investigate similarities and differences in butchery and carcass acquisition strategies practiced by hominids at KRM1 and hominids at FLK. Additionally, interpretations offered here are often guided by the carnivore consumption sequence (Blumenschine 1986a) and utility indices (e.g., Binford 1978; Blumenschine & Caro 1986). Blumenschine’s (1986a) general flesh consumption sequence is used, but for corresponding and additional information also see Blumenschine (1988a), Blumenschine and Marean (1993), Bunn and Ezzo (1993), and Gifford-Gonzalez (1989a).

6.3.2. Issues concerning methods of recording and quantifying cut marks

I focus on Milo’s (1994, 1998) interpretations of the cut marked bones from KRM1 because, unlike Binford’s (1984c) naked-eye examination of bone surfaces, Milo conducted an exhaustive stereomicroscopic study of all bone surfaces. Milo (1994, 1998) demonstrated that a significant number of cut marks were not visible without magnification (also see Blumenschine et al. 1996; Bunn 1991; Cruz-Uribe & Klein 1994; Lyman 1987a), and that numerous cut marks were only detected after bones were cleaned of adhering matrix. Milo’s examination doubled Binford’s (1984c) cut mark tally. Milo (1998: 102) stresses the
importance of microscopically aided detection of cuts because he notes that up to 70% of cut marks may vanish due to taphonomic processes, and that this may, in part, account for major discrepancies in cut mark frequencies between different assemblages (see also Lyman 1987a, 1995). Consequently, every effort should be made to recover all remaining cut marks through exhaustive microscopic examination (e.g., Blumenschine et al. 1996; Milo 1994, 1998).

‘Unidentifiable’ limb bone shaft fragments were normally not collected during early excavations at KRM (Klein 1976; Singer & Wymer 1982). Marean (1998; Marean & Kim 1998) demonstrated the biasing effect of excluding shaft fragments from faunal analyses. Milo points out that the presence of filleting cuts on shaft portions still attached to epiphyses indicates that the filleting signature is probably under represented because of missing shaft fragments. Because of this discrepancy, shaft portions are largely excluded when MRM and KRM1 are compared in the current study.

Milo (1998) tabulated his cut mark data relative to NISP (Number of Identifiable Specimens) and MNI (Minimum Number of Individuals), but restricted his statistical analysis to NISP. Calculations of MNI and MNE (Minimum Number of Elements) partly resolve the problem of differential fragmentation and preservation. Milo calculated MNI and MNE using methods developed by Klein and Cruz-Uribe (1984). I describe the calculation of MNI and MNE for pelves using the Klein and Cruz-Uribe procedure, because in the present study pelves are regarded as important indicators of carcass acquisition strategies. This is due to pelves being associated with large amounts of meat (Blumenschine & Caro 1986) and because pelves rank highest of appendicular elements in the carnivore flesh consumption sequence (Blumenschine 1986a). The procedure developed by Klein and Cruz-Uribe (1984) and employed by Milo (1994, 1998, 1999 personal communication), calculates MNIs for pelves by counting portions of acetabulae. “Therefore, a virtually complete iliac blade and shaft, if it has no portion of the acetabulum, does not figure in the calculation of MNI or MNE. Therefore, the MNI and MNE divisor I used for calculating mean cut mark frequencies (MCF) was the acetabulum figure, both for acetabulae and shafts” (Milo 1999 personal communication). Milo recognized the affect of this calculation on the MCF on non-acetabular pelvis portions and is resolving the computing difficulty for future collaboration with the present author. Since pelvis shafts are less durable than acetabulae (e.g., Blumenschine & Marean 1993; Brain 1981; Grayson 1989; Klein 1989b; Lam 1992; Lam et al. 1998; Lyman 1984, 1985; Marean et al. 1992; Woodborne 1996 and references therein), MNE estimates of non-acetabular portions calculated by counting non-acetabular fragments will in all likelihood
be lower than those calculated on acetabulae. Consequently, with lower MNEs for non-acetabular pelvis portions calculated on non-acetabular fragments, the MCFs for shafts is expected to increase. This hypothesis may be tested by recalculating MNEs and MCFs for pelvis shafts at KRM1. With respect to cut mark data, this example demonstrates and stresses the importance, alluded to below, of calculating MNEs for anatomical portions by using fragments representing the appropriate portions and not by using MNEs for complete elements or MNEs for portions other than the one in question. Standardizing this quantitative procedure is critical to render cut mark data from different archaeological assemblages directly comparable (for example see Bartram 1993a: 209-218).

Since bones in the MRM assemblage are not fragmented, NISP is not an appropriate quantitative unit for comparing the MRM and KRM1 cut mark data. Additionally, because hominids conceivably retrieved parts of some carcasses (elements) rather than complete carcasses (animals) by hunting and/or scavenging (e.g., Blumenschine 1986c, 1987; Marean 1989), as modern hunter-gatherers still do (e.g., Bartram 1993a; Bunn et al. 1988; O'Connell et al. 1988a; Yellen 1977b), I propose the use of MNE rather than MNI (also see Bartram 1993a; Binford 1984; Milo 1994). Additionally, butchers process elements and element portions (MNE) rather than entire carcasses (MNI). Further, specific butchery activities are associated with specific elements and portions and not with entire carcasses. I demonstrate below that it is at the element and anatomical portion level that differential proportions of cut mark frequencies across different anatomical portions inform about butchery and carcass acquisition strategies. Like MNI, MNE partly resolves the problem of differential fragmentation and preservation. As argued above, and specifically regarding cut mark studies, MNEs should be calculated for each anatomical portion, and not be derived from the MNE estimate for a given skeletal element or portion. The latter procedure in all likelihood results in biasing, owing to differential fragmentation and survival potential of different portions of the same element (e.g., Blumenschine & Marean 1993; Brain 1981; Grayson 1989; Klein 1989b; Lam 1992; Lam et al. 1998; Lyman 1984, 1985, 1991; Marean et al. 1992; Woodborne 1996 and references therein).

Although Milo (1998) presents cut mark data as cut marked pieces per NISP (e.g., Table 2), his Table 6 indicates that individual cut marks were tallied (Milo 1993 personal communication), making the KRM1 data directly comparable with those from MRM. With the exception of pelves, as explained above, Milo calculated MNEs for each anatomical portion according to the representation of specimens for a given portion (Milo 1999 personal
communication), thereby partly controlling for differential fragmentation and survival potential. Since shaft fragments were typically not collected during excavations (Klein 1976; Singer & Wymer 1982), he used the lower of the MNEs for either distal or proximal ends of a given element as the MNE for the shaft of that element (Milo 1999 personal communication). Due to sampling biases, mid shaft portions are largely excluded from comparisons made in the current study. Milo (1998) also calculated mean cut mark frequencies (MCFs) per MNI and MNE as well as relative mean cut mark frequencies (rMCFs) per MNI and MNE. The latter are employed in this study since I demonstrate below and in section 6.4 that the proportional distribution of mean cut mark frequencies (PDMCF or % MCF or rMCF) is an effective gauge of butchery and carcass acquisition strategies. Mean cut mark frequencies per MNE for the KRM1 assemblage, as used and modified here, were provided by Milo (1999 personal communication) at my request.

Milo (1998: 109-112) proposes and provisionally applies a new method for documenting filleting versus disarticulation through the calculation of relative mean cut mark frequencies (rMCF) and combined relative mean cut mark frequencies (Combined rMCF). This method enables analysts to evaluate butchery by the relative distribution of actual cut marks. In my opinion, this is the most effective method for evaluating butchery and carcass acquisition strategies - with cut mark data - thus far formulated (but see Selvaggio 1998). I substantiate this proposal below and in section 6.4. The same index (rMCF), here referred to as the proportional distribution of mean cut mark frequencies (PDMCF or % MCF), was developed independently by the present author and is calculated in the same manner (see section 6.4.2). While the same in principle, Milo’s rMCF and combined rMCF, as tabulated in his 1998 publication, are problematic because of certain fundamental shortcomings in the actualistic frameworks on which his tabulations are founded.

In the absence of shaft specimens, “An alternative to recording the frequencies of tool-marked shaft fragments is to examine the relative distributions of the butchering marks themselves. This procedure begins with a tabulation of the individual butchering marks on all of the specimens, apportioning the marks between disarticulation and filleting following Binford (1978, 1981), Gifford-Gonzalez (1989) and my own experiments” (Milo 1998: 109). In chapter 5 I demonstrated that many of Binford’s (1981) behavioural correlates for coded cut marks are incorrect, and I discuss elsewhere that the palimpsest predicament of overprinted butchery activities was not circumvented in actualistic studies, and where analysts perform their own butchery (e.g., Bunn 1985; Gifford-Gonzalez 1989a; Milo 1994,
1998), the unconscious expression of research biases as well as the lack of butchery experience is a concern (but see Selvaggio 1998). Milo’s (1998) combined rMCFs are problematic for the above-mentioned reasons. Nevertheless, and more importantly, Milo already recognized the potential of relative distributions of cut marks for investigating butchery related behaviour.

My opinion regarding the analytical and interpretative value of the proportional distribution of mean cut mark frequencies is supported by Milo when he states that “…the method has analytical utility in archaeofaunal butchering studies in general; since the patterning reflects numbers of marks and not numbers of marked elements, the two classes of patterning can potentially be used to check for consistency of interpretation” (Milo 1998: 110). On the same page, however, he points out that “The rMCF data for the KRM bovids cannot be closely interpreted in the absence of an actualistic standard against which to compare the patterns …”. The MRM data provides an actualistic standard against which archaeological assemblages can be compared. I caution that while the MRM assemblage is a good starting point, additional assemblages from actualistic butcheries – controlled in the same manner - are essential to test and strengthen the analogue. Nevertheless, the MRM study has set the stage.

As Milo (1998: 109-110) notes, MCFs render cut mark frequencies on disproportionately represented elements and portions directly comparable. By dividing the number of cuts by the MNI or MNE, therefore partly circumventing the differential fragmentation and preservation quandary, cut mark frequencies on unequally represented elements and portions are directly comparable.

Proportional distributions of MCF per MNE at different anatomical portions by skeletal element and across the skeleton were calculated in the current study by using data from KRM1 provided by Milo (1999 personal communication). The latter indices, as well as MCF, were compared with data from MRM (see section 6.4.2 for calculation procedures). Because the MRM actualistic sample is too small to divide data according to animal size class, I compared the small and large bovid data from MRM with bovid size class II and IV from KRM1 respectively. I recognize that lumping size classes may disguise actual differences between individual size classes (e.g., Gifford-Gonzalez 1989a; Marshall 1986; Milo 1998; O'Connell et al. 1990), but the limited actualistic sample precluded separation of size classes. Nevertheless, results from comparisons between MRM and KRM1 presented below indicate that certain patterns are not significantly affected by this shortcoming. The decision to
compare the MRM small bovids with KRM1 size class II and MRM large bovids with KRM1 size class IV was made because the majority of animals comprising the MRM small bovid category are size class II bovids (Antidorcas marsupialis), while those in the MRM large bovid category are predominantly size class IV (Taurotragus oryx).

Anatomical portions of appendicular elements as displayed in Appendix D, are equivalent to those employed by Milo (1993 personal communication) and therefore frequencies of cut marks on appendicular portions in the MRM and KRM1 assemblages are directly comparable. Exceptions include anatomical portions of scapulae and pelves. My shaft and distal shaft portions for scapulae were lumped for comparison with Milo’s shaft portion for scapulae. Only shaft and acetabulum portions of pelves were used in comparisons between MRM and KRM1. All the MRM rib portions are lumped for comparison with the KRM1 material since the data provided by Milo does not distinguish between different rib portions.

Due to certain methodological constraints outlined above, I briefly summarise some of Milo’s (1998) interpretations of the cut marked bones from KRM1 in section 6.3.3 before making comparisons between the MRM and KRM1 data (modified in this study). Discussions of the comparison between MRM and KRM1 are restricted to the most prominent results. Milo and I will study the cut mark information in more detail in the near future. Then the KRM1 cut mark data, as well as methodological themes, will be investigated exhaustively in light of the MRM actualistic assemblage. Proportional distributions of mean cut mark frequencies per MNE by skeletal element for KRM1 and MRM (filleted and filleted and disarticulated samples given separately) are presented in Table 6.1 and Figures 6.1 and 6.2. These data and illustrations are presented for the reader to follow calculation procedures and to facilitate comparisons between the two assemblages. When the assemblages are compared in section 6.3.3, all cut marks from MRM are used for reasons given in section 6.4.3.
Table 6.1. Cut mark frequencies per MNE and standardised frequency distributions of cut marks across different anatomical loci. Values in the first KRM1 columns represent data from Klasies River Mouth (Milo, personal communication; also see Milo 1994, 1998) and values in MRM columns are from the current study and derived from Tables 4.39 and 4.40. The filleted and disarticulated sample for small bovids is excluded due to sample size. Fill & dis = filleted and disarticulated sample. MCFs per MNE are given where percentages could not be calculated.

<table>
<thead>
<tr>
<th>Element</th>
<th>Small Bovids</th>
<th>Large Bovids</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All cuts</td>
<td>Filleting cuts</td>
</tr>
<tr>
<td></td>
<td>KRM1</td>
<td>MRM</td>
</tr>
<tr>
<td>Scapula</td>
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<td></td>
</tr>
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<td>1.3</td>
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<tr>
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<td></td>
</tr>
<tr>
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<td>0.0</td>
</tr>
<tr>
<td>PS</td>
<td>0.0</td>
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</tr>
<tr>
<td>DS</td>
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<td>3.2</td>
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</table>
Figure 6.1. Proportional distribution of mean cut mark frequencies (% MCF) across different anatomical loci by element for small bovids from (a) MRM (excluding the filleted and disarticulated sample) and (b) KRM1. Mid shaft portions are excluded except for tibiae.
Figure 6.2. Proportional distribution of mean cut mark frequencies (% MCF) across different anatomical loci by element for large bovids from (a) MRM (values on left = filleted only and those on right = filleted and disarticulated) and (b) KRM1. Mid shaft portions are excluded except for radii.
6.3.3. Reconstructing butchery and carcass acquisition strategies practised by hominids at KRM1

I provide a broad summary of Milo’s reconstruction of hominid behaviour based on cut marked bones from KRM1 as well as other damage to bones, including the “broken tip of a stone point” lodged in a *Pelorovis antiquus* cervical vertebra (1998: 123). This is followed by a more detailed evaluation of his interpretations with respect to more detailed cut mark data. Analyses of cut mark locations, as presented in the figures for chapter 4, are excluded as similar detail was not presented by Milo (1994, 1998). Finally, the cut mark data from KRM1 and MRM are compared according to mean cut mark frequencies (MCF) and the proportional distribution of mean cut mark frequencies (rMCF or % MCF) across different anatomical portions of the skeleton and by element.

Milo (1998: 124) suggests that the stone tip embedded in the neck of a *Pelorovis* is the first evidence for MSA hominids killing large animals with weapons. Milo argues that this animal was hunted and possibly killed in a pit trap (Milo 1998: 124-126). The argument of hominids hunting eland at KRM1, possibly driving animals off a cliff, is apparently supported by cut mark data as well as a catastrophic mortality profile for eland (Klein & Cruz-Uribe 1996; Milo 1994, 1998). There is, however, no evidence for drive sites in South Africa, although such sites are common in North America (e.g., Frison 1970, 1971a, 1974; Wheat 1972). Further, a catastrophic mortality profile witnesses random sampling of a living population, but there is no evidence that the eland at KRM1 died in a series of mass kills.

The evidence for hunting *Pelorovis* is inferred. A stone tip lodged in the neck of a giant buffalo may provide evidence for hominids being actively involved with the animal’s death, yet the archaeological evidence for hunting is more elusive. It is conceivable that the stone point was lodged in the vertebra through sticking a butchery tool into the animal’s neck. An alternative scenario may be envisaged where non-hominid predators bring down and incapacitate a giant buffalo, and are seen by observant and opportunistic hominids. Aggressive and not overly slow-witted hominids - through power in numbers, blaring vocalizations, and brandishing objects - manage to drive original predators from the writhing buffalo. An analogous scenario was observed ethnographically. “The lions had eaten the intestines and part of the one upper hind quarter. The Hadza frightened away the lions by shooting arrows at them; then cut the carcass into several pieces and carried it …” (O’Connell *et al.* 1992: 5; also see Bunn *et al.* 1988; O’Connell *et al.* 1988a, 1988b, 1990).
Hominids kill the animal by thrusting stone tipped spears into vital parts including the neck. Deeply lodged in the animal’s neck, one spear tip is snapped through tensile forces as the animal dies squirming. This alternative scenario does not undermine the interpretation that hominids at KRM1 were involved in coordinated group activities. That certain body parts were successfully retrieved and butchered at KRM1, suggests that hominids were not acting individually or passively. It is difficult to imagine a single hominid, or even a solitary lion or hyaena, successfully gaining access to sought-after animal products in a landscape shared with aggressive and socially organized non-hominid carnivores.

Milo (1998: 124) argues that the collective evidence suggests that hominids were the prime accumulators of bone in the KRM1 assemblage and that carnivores were not ravaging carcasses before hominids acquired them. Overall, the butchery pattern, and specifically that of bovids in size class IV (including many eland), is interpreted by Milo as a “hint at behaviour presaging the modern condition” (1998: 124). This is based on his observation of a “distinctive eland butchering pattern” (Milo 1998: 125) and Klein & Cruz-Uribe’s (1996) reconstruction of a hunting technique requiring group cooperation and coordination. Along with the argument for pit-trap hunting, Milo interprets these lines of evidence as indicative of “task-group formation” and states that “This kind of task-group formation has been argued to be a characteristic of modern human behaviour (Reynolds 1993)” (Milo 1998: 125). His final conclusion is that “… some aspects of their [hominids’] behaviour – perhaps especially their social behaviour – were already approaching the modern condition” (Milo 1998: 126). Milo suggests that the KRM1 data should be compared with other contemporaneous sites to determine whether behaviour observed among hominids at KRM1 resembles that of other hominids. In section 6.5, in this regard, I briefly compare the KRM1 cut mark data with that from FLK *Zinjanthropus*. The purpose of this comparison is to determine whether the methodology employed below and in section 6.4 is sensitive to differences in butchery as practiced by hominids in the Upper Pleistocene and Plio-Pleistocene, separated in time by about 1.7 million years. In all likelihood, real differences do exist, but are they detectable through cut mark patterning and with the methodology employed here? In sum, section 6.5 attempts to answer the question; did MSA hominids at KRM1 acquire and butcher animals like their Early Stone Age hominid predecessors at FLK *Zinjanthropus*, or had hominid carcass acquisition skills evolved by the time KRM1 was occupied?

Milo’s (1998) initial interpretations of the cut marks are based on traditional counts of cut marked pieces and proportions of cut pieces per MNI for specific anatomical portions. He
observes that cut mark frequencies on high- and low-ranked portions are very similar, and “Assuming that roughly equal damage frequencies reflect roughly equal access, these figures suggest that KRM hominids had access to the meatiest portions of bovids in all size classes” (Milo 1998: 103). The MRM data indicate that this assumption is not warranted since overall MCFs on front limbs decrease from 22.2 (small bovids) and 78.4 (large bovids) on scapulae, to 13.0 (small bovids) and 31.3 (large bovids) on humeri, to 2.8 (small bovids) and 11.5 (large bovids) on radii, and to 1.1 (small bovids) and 10.4 (large bovids) on ulnae. A similar pattern is seen in the overall MCFs for rear limbs in the MRM assemblage where cut mark frequencies decrease from 10.4 (small bovids) and 58.1 (large bovids) on pelves, to 9.8 (small bovids) and 35.7 (large bovids) on femora, and to 3.7 (small bovids) and 9.2 (large bovids) on tibiae. Remember that butchers at MRM had full and uninterrupted access to carcasses and processed them equally and thoroughly. The MRM data demonstrate that, as logic may prescribe, bones with more meat generally require more effort to deflesh and are consequently more frequently cut marked.

This notion is supported by the fact that the bones of large bovids from MRM retain significantly more cut marks relative to small bovids. Also, bones with complex architecture (such as scapulae and pelves) are likely to be impacted more often than relatively uncomplicated, long and rounded bones (like femora and humeri). In the MRM assemblage we see that small and large bovid scapulae and pelves retain the highest MCFs of appendicular elements on the front and rear limbs respectively. The MRM data ‘imply’ that equal cut mark frequencies on meaty and non meaty limb bones are not expected if access to carcasses was equal, and a pattern of roughly equal MCFs on meaty and less meaty limb bones indicates unequal rather than equal access to and/or processing of different elements (contra Milo 1998). Meaty limb bones should retain more cut marks than non meaty limb bones if all bones were fully fleshed when procured. This discussion is continued below when I compare the proportional distribution of cut marks from the MRM and KRM1 assemblages.

Regarding cut mark frequencies for different bovid size classes, Milo (1998) notes that cut mark frequencies do not increase with size as may be expected. Cut mark frequencies on KRM1 bovids decrease from size II to IV, and then cut mark frequencies increase again for size class V. He offers some explanations for this pattern (Milo 1998: 105-109). Overall, Milo suggests that “all of the KRM bovids were disarticulated and filleted in broadly similar ways …” (1998: 105) and “… the data presented so far seem to leave little doubt that the
MSA hominids at KRM actively obtained whole bovid carcasses in all size classes” (1998: 109). Below I evaluate Milo’s last two interpretations by comparing the KRM1 cut mark data with that from MRM.

While Table 6.1 and Figures 6.1 and 6.2 above provide raw data and % MCFs per MNE by element for the filleted, and filleted and disarticulated samples separately (MRM), the following comparisons are based on all the cut marks in the MRM assemblage unless stated otherwise. This decision was made because using the filleted sample alone would undoubtedly result in under representation of cut marks on epiphyses, and the filleted and disarticulated sample is too small to use in isolation. Only appendicular elements (excluding metapodials and phalanges) and sometimes ribs are included in comparisons. This decision was made because appendicular bones are generally better represented in archaeological assemblages, and because I believe appendicular elements, particularly the meaty bones of upper limbs, are valuable indicators of butchery and carcass acquisitions strategies. Note that cuts on non-meaty lower limb bones, apart from being produced by removing periosteum, may be indicative of removing tendons and ligaments while upper meaty limb bones are not associated with similar tendons and ligaments, and therefore cuts on proximal, mid, and distal shafts of meaty limb bones are overwhelmingly the result of filleting (personal observations; Shipman 1988a). The proposal that upper limb bones are valuable indicators of butchery and carcass acquisition strategies is amplified and supported below and in section 6.4.

First the small and large bovids at MRM are compared (according to a, b, and c described below), then the small and large bovids at KRM1 are compared (according to a, b, and c described below), and finally the small bovids from MRM and KRM1, and large bovids from MRM and KRM1 are compared separately. The comparisons within and between the assemblages include; a) the mean cut mark frequencies (MCF), b) the proportional distribution of mean cut mark frequencies (rMCF or % MCF) across different anatomical portions of the skeleton, and c) the rMCF or % MCF at different anatomical portions by element on small and large bovid bones.

To determine the significance of correlation between different samples, Spearman’s rank correlation coefficient was used (Blalock 1972). This test was selected because it is conservative and because it treats data as ordinal values. Microsoft Excel 97 was used for the analysis.
6.3.3.1. A comparison of cut marks on small and large bovid bones from MRM and KRM1

In section 4.5.3 above a Mann-Whitney U-Test (Sokal & Rohlf 1981) revealed a significant difference in the mean cut mark frequencies between small and large bovids in the MRM assemblage. Bones of large bovids retained significantly more cut marks per anatomical portion than small bovid bones ($U_s = 269.5$, $P < 0.001$). This is presented graphically in Figure 6.3. For both small and large bovids, the highest MCFs are on scapulae and pelves, though the MCFs are considerably higher for large than small bovids. Correlation analysis demonstrates that, in the MRM assemblage, small and large bovid MCFs are significantly correlated ($r_s = 0.94$, $P < 0.05$). Although small bovids retain significantly fewer cut marks than large bovids, the MCFs are significantly correlated.

(a)

![Graph showing MCF per MNE for small and large bovids](image-url)
Figure 6.3. Distribution of MCFs per MNE on (a) front and (b) rear limbs and ribs of small and large bovid bones from the MRM assemblage.

A Mann-Whitney U-Test shows that the MCFs for small and large bovids at KRM1 are not significantly different ($t_s = 1.4107$, $P > 0.1$) and correlation analysis shows that the distribution of MCFs across different anatomical portions of the two bovid size groups are significantly correlated ($r_s = 0.75$, $P < 0.05$). Bear in mind that the effects of fragmentation were partly circumvented by calculating MCFs per element and portion and, as a result, frequencies are directly comparable and the similarity in MCFs on small and large bovids is realistic and not an artefact of fragmentation. According to the MRM data we expect that large bovids should retain significantly higher MCFs than small bovids, but this is not the case at KRM1. As I have reasoned elsewhere, this implies that overall, small and large bovids were butchered and/or acquired differently. Figure 6.4 shows that MCFs for small and large bovids are similar for many elements, particularly on rear limbs. This suggests a standardized or consistent butchery strategy employed for processing both small and large bovid carcasses at KRM1. Given this correlation in MCFs across different anatomical portions (indicating similar butchery strategies), it is intriguing that large bovids do not consistently retain higher MCFs relative to small bovids (possibly indicating differences in carcass acquisition) as can be expected from the MRM assemblage. It is most likely, according to the MRM data, that hominids at KRM1 did not have the same access to large animals as they did to small animals. Large bovid carcasses may have been acquired with less meat relative to small bovid carcasses. This notion is discussed in more detail later.
Concerning the proportional distribution of MCFs across different anatomical portions of the skeleton, a correlation analysis demonstrates a significant correlation between small and large bovids in the MRM assemblage ($r_s = 0.94$, $P < 0.05$). This is expected since animals in the actualistic study were acquired and butchered uniformly. Figure 6.5 shows that similar butchery strategies and equal access to carcasses at MRM are clearly reflected in the distribution of % MCFs across different anatomical portions of the skeleton. Documenting a similar pattern for an archaeological assemblage may indicate a consistent butchery strategy.
and equal access to animal carcasses. This suggestion is investigated below when MRM and KRM1 are compared.

![Graph a](image1)

![Graph b](image2)

Figure 6.5. Proportional distribution of MCFs per MNE across different anatomical loci of the skeleton on (a) front and (b) rear limbs and ribs of small and large bovid bones from the MRM assemblage.

A correlation analysis reveals that the proportional distribution of MCFs across different anatomical loci of the skeleton on small and large bovids at KRM1 are significantly correlated ($r_s = 0.57$, $P < 0.05$). Overall, this suggests that similar strategies were employed.
for processing small and large bovids at KRM1. Interestingly, Figure 6.6 shows that % MCFs on scapulae, rear limb bones and ribs are quite similar. This suggests that differences in butchering and/or access to carcass parts of small and large bovids at KRM1 are most marked on the front limb bones, apart from scapulae. Since rear limbs are higher on the carnivore flesh consumption sequence (Blumenschine 1986a) we may expect the difference in the % MCFs to be on rear limb elements and not front limbs if carcasses were scavenged from non-hominid carnivore kills. Similar % MCFs on rear limbs of small and large bovids suggest that hominids at KRM1 butchered small and large animals in similar ways. With respect to the carnivore consumption sequence it is intriguing that the difference lies at the front limbs. More detailed discussion and interpretation stems from comparing MRM and KRM1 below.

(a)

% MCF of total MCF for small & large bovids

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<th>Element and Portion</th>
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Percentage

0.0 2.0 4.0 6.0 8.0 10.0 12.0
Figure 6.6. Proportional distribution of MCFs per MNE across different anatomical loci of the skeleton on (a) front and (b) rear limb bones and ribs of small and large bovids from KRM1.

A correlation analysis shows the proportional distribution of cut marks by skeletal element for small and large bovids are significantly correlated ($r_s = 0.61, P < 0.05$). Figure 6.7 demonstrates that for many elements and portions, the proportional distribution of cut marks on small and large bovids from MRM are similar. The most marked differences occur on radius shafts, proximal ulna shafts, proximal tibiae, patellae, and tarsal bones. Since these elements are not associated with large quantities of meat (Blumenschine & Caro 1986), differences in % MCFs on these elements are not critical to interpretations of butchery and/or carcass acquisition strategies. Overall, the observation that butchers at MRM processed small and large bovids uniformly is reflected in the correlation result and the distribution of the % MCFs in Figure 6.7. An archaeological situation approaching this pattern may indicate equal access to carcasses in different size groups and/or standardised butchery strategies in processing different size animals.
Figure 6.7. Proportional distribution of MCFs per MNE across different anatomical loci by skeletal element on (a) front and (b) rear limbs and ribs of small and large bovid bones in the MRM assemblage.

A correlation analysis of the proportional distribution of cut marks across different anatomical loci by element for small and large bovids in the KRM1 assemblage reveals a significant correlation between the size groups ($r_s = 0.58$, $P < 0.05$). Figure 6.8 shows that for some elements and anatomical portions, for example scapulae, distal humeri, proximal radius shafts, proximal epiphyses of ulnae, and pelves, the % MCFs are remarkably similar for small and large bovids at KRM1. This suggests that certain elements of small and large bovids were processed similarly by hominids at KRM1. At the intra-site level, it appears that for certain
elements the butchery strategy was at least consistent if not thorough. I suggest not thorough, because MCFs are not significantly higher on large bovid bones than on small bovid bones in the KRM1 assemblage. As discussed above, if access to large and small bovids was equal, we may expect a pattern similar to that observed in the MRM assemblage where access to carcasses was equal and where large bovid bones retain significantly higher MCFs than small bovid bones. It appears, therefore, that large bovids were not acquired with the same quantities of flesh as small bovids at KRM1.

Figure 6.8. Proportional distribution of MCFs per MNE across different anatomical loci by skeletal element on (a) front and (b) rear limb bones and ribs of small and large bovids from KRM1.
6.3.3.2. A comparison of cut marks on small bovid bones from MRM and KRM1

I now turn to inter-site comparisons of cut mark data from MRM and KRM1, starting with small bovids. Since only one small bovid was filleted and disarticulated in the MRM study, cut marks are anticipated to be under represented at epiphyses. Nevertheless, I performed a Mann-Whitney U-Test comparing the MCFs on small bovid bones from MRM and KRM1, including only the filleted sample from MRM. For other comparisons made below all cut marks were included, but the reader is reminded that disarticulation is under represented in the MRM assemblage. Higher cut mark frequencies at epiphyses are anticipated if more animals were disarticulated during actualistic butchery. This shortcoming does not appear to affect the overall patterning significantly, but analysts comparing the MRM cut mark data with those from archaeological sites should allow for a certain amount of variation between cut mark frequencies on epiphyses in an archaeological assemblage and in the MRM assemblage. In all likelihood, archaeological assemblages will retain higher MCFs at epiphyses than those documented for MRM.

Quite remarkably, despite the foregoing discussion, a Mann-Whitney U-test shows that the MCFs are not significantly different for the two assemblages ($t_s = 0.84, P > 0.4$). Additionally, a correlation analysis shows that the distribution of MCFs from the two assemblages are significantly correlated ($r_s = 0.41, P < 0.05$). These result are surprising considering all the variables (skill, handedness, and strength of butchers, transport considerations, size of carrying party, condition of carcass, differential access to carcass parts, etc.) capable of affecting butchery, and the fact that the MRM butchers generated cut marks predominantly with metal tools in 1993 while hominids at KRM1 did the same but with stone tools some 100,000 years earlier. One may reasonably hypothesize that, if more animals were filleted and disarticulated in the MRM small bovid assemblage, then the MCFs from the two assemblages are likely to be more alike in both frequency and distribution. Although Figure 6.9 shows that the MRM assemblage generally retains somewhat higher MCFs than KRM1 – possibly due to the predominant use of metal at MRM and exclusive use of stone at KRM1 - this visual difference is not statistically significant. On the whole, this indicates that butchers at MRM and KRM1 were generating similar numbers of cut marks as well as similar distributions of MCFs across different anatomical portions. This strongly suggests that hominids at KRM1 had full access to small bovids and processed them thoroughly. It is surprising that metal tools do not leave significantly higher cut mark frequencies than stone tools, and this observation implies that data from actualistic butchery
conducted with metal tools may be used to evaluate cut mark data from Stone Age sites. Additional actualistic research is required to establish the exact variation between cut marks produced by metal and those produced by stone.

(a)

![Graph](a)

(b)

![Graph](b)

Figure 6.9. Distribution of MCFs per MNE on small bovid (a) front limb bones and (b) rear limb bones and ribs from MRM (all cut marks) and KRM1.

The following discussion stems from a comparison between the % MCFs across different anatomical loci of the appendicular skeleton and ribs of small bovids from MRM and KRM1 (Figure 6.10). A correlation analysis shows that the two assemblages are significantly
correlated \( (r_s = 0.41, P < 0.05) \). This implies that small bovids at KRM1 were acquired and butchered in ways similar to those observed at MRM. Because factors affecting butchery are so complex, varied, and numerous, this is a remarkable result. Examination of Figure 6.10, however, shows that the % MCF of the total MCF are different for certain elements in the two assemblages, particularly the scapula shaft, proximal epiphysis of the radius, carpals, pelvis, proximal and distal epiphyses of tibia, naviculo-cuboid, and ribs. For the remaining element portions the two assemblages are not markedly different. The differences between the % MCF at the above-listed element portions can be rationalized. Lower cut mark frequencies on scapula shafts in the KRM1 assemblage compared with MRM, may result from differences in tool technology. Stone may produce somewhat lower cut mark frequencies than metal. Nevertheless, with the exception of ribs, scapulae at KRM1 are more frequently cut marked than most anatomical portions and are cut marked more or less as frequently as pelves. This is expected in view of the MRM data since scapulae are associated with a lot of meat and their morphological structure causes butchers to make a lot of tool to bone contact. High MCFs on scapulae suggest full access and thorough butchery. Scapulae do not retain marrow and are therefore unlikely to be cleaned or scraped (cut marked) for marrow processing (personal observations; Lupo 1998; Outram & Rowley-Conwy 1998).

I propose that higher MCFs on proximal radius epiphyses at KRM1 is in part explicable due to the small number of disarticulated animals in the MRM assemblage. Interestingly, distal epiphyses of humeri are more frequently cut at MRM than KRM1 (Figure 6.10). This suggests that during disarticulation of the humerus from the radio-ulna at KRM1, butchers were more frequently impacting the proximal radius than the distal humerus. A larger sample of actualistically disarticulated animals may resolve the reason for this discrepancy. Cuts at epiphyses, however, may result from either filleting or disarticulation and therefore cuts at this locality do not necessarily indicate earlier or later access to carcasses. The paucity of cuts on the KRM1 carpals is interesting considering that MCFs on other elements indicate more or less full access to small bovids. A possible explanation for this observation is that, given the relative weakness of small bovid joints, the metacarpal may have been disarticulated from the radio-ulna by placing the carpals on a stone pivot and forcing the metacarpal and radio-ulna down on both ends, thus snapping the joint. Other methods of breaching the joint can be imagined. Another possibility is that the bones were not disarticulated at all and simply fractured for marrow while articulated. Again, cuts at carpals are associated with disarticulation and do not directly inform about carcass acquisition strategies. The paucity of
cuts on KRM1 carpals, therefore, does not imply late access, it simply implies an alternative method of marrow extraction.

As explained in section 6.3.2, the calculation of MNEs for pelves in the KRM1 assemblage is problematic, and underrepresentation of cut marks on pelvis shafts can be explained by the probable exaggeration in MNEs for this part. Revised calculations are required to make realistic interpretations. Patellae are situated between limb bones and are not associated with large amounts of meat (Blumenschine & Caro 1986; personal observations). The main reason for the paucity of cuts on MRM patellae is likely due to the small sample of disarticulated animals in the actualistic assemblage. Additionally, tissues around patellae are very sinuous, and particularly for small bovids, this meat is not used for making biltong or sausage (personal observations). Patellae, however, are cut marked frequently during filleting of large bovids in the MRM assemblage. Cuts are present on KRM1 patellae and therefore lack of access to carcasses is not implied.

Lower cut mark frequencies on naviculo-cuboids at KRM1 may be due to alternative methods of disarticulation necessitated by differences in butchery tools. The blades of metal tools, as used at MRM, are pliable, thin in section, and possess sharp points. Metal blades are therefore readily inserted between closely articulating bones, and levered back and forth to cut through connective tissues and ligaments without snapping the blade or point. On the other hand, stone tools as used at KRM1 and in general, are brittle and usually considerably broader in section than metal blades. Also, stone flakes generally lack the very sharp points which are characteristic of metal knives. Because stone blades are not as thin as metal ones, they can not easily be inserted between closely articulating bones, and because they are brittle, stone tools are likely to snap if inserted and levered between bones. High proportions of cut marks on the distal epiphyses of tibiae and on astragali at KRM1 suggest that, butchers were disarticulating metatarsals from tibiae somewhat differently from the strategy employed at MRM. As discussed above, I suggest this is probably due to differences in tool technology. Comparing cut mark data from Iron Age sites with those from Stone Age sites predating the introduction of metal, would shed some light on this issue. Nevertheless, proportional distributions of cuts appear to be sensitive to fairly detailed differences in butchery strategies.

Ribs retain higher frequencies of cuts at KRM1 than at MRM, which indicates that butchers were defleshing ribs thoroughly at KRM1. Excluding the scapula shaft, and taking into account the above discussion, the % MCFs for MRM and KRM1, across anatomical portions are not markedly different for the large majority of elements and portions included in
the current study. Provisionally, this and the correlation result strongly suggests that the KRM1 butchers acquired at least early, if not full access to the carcasses of small bovids. In addition, Milo (1999 personal communication) has recorded cut marks on medial surfaces of rib shafts, and I have argued in sections 4.5.6 and 5.4.8 that these cuts are unambiguously associated with evisceration (see Figures 4.276, 4.278). Given that viscera are among the first animal tissues consumed in the carnivore flesh consumption sequence (Blumenschine 1986a), evisceration cuts provide compelling evidence for early, if not full access to animal carcasses. Hunting of small bovids at KRM1 is a strong possibility, but scavenging from tree-stored leopard kills can not be ruled out (Cavallo & Blumenschine 1989). Because small bovid carcasses are rapidly cleaned of meat and almost completely consumed by some non-hominid carnivores (e.g., Blumenschine 1986a), tree-stored leopard kills offer a unique opportunity for hominid scavenging of small bovid carcasses (Cavallo & Blumenschine 1989). It is unlikely, however, that hominids would always (reflected in the consistent pattern of high rMCFs on elements associated with large amounts of meat) be successful in robbing complete small bovid carcasses from non-hominid carnivores. It is likely, therefore, that hominids were hunting at least some small bovids. Nevertheless, unequivocal archaeological evidence for hunting remains elusive. The distribution of MCFs, % MCFs and the presence of evisceration cut marks, however, provide compelling support for the hunting of small bovids at KRM1 as proposed by Milo (1998; also see Binford 1984c).
Figure 6.10. Proportional distribution of MCFs per MNE across different anatomical loci on (a) front limb bones and (b) rear limb bones and ribs of small bovids from MRM (all cut marks) and KRM1.

The proportional distribution of MCFs across different anatomical loci by element on small bovid bones from MRM and KRM1 are presented in Figure 6.11 and a correlation analysis reveals that the two assemblages are significantly correlated ($r_s = 0.40$, $P < 0.05$). Along with the evidence provided above, this demonstrates that hominids at KRM were acquiring small bovids and butchering them in ways similar to those observed at MRM. On the front limb, proportions of cut marks on scapula shafts and epiphyses are remarkably similar between the two assemblages (Figure 6.11). Proportionately higher frequencies on scapula shafts in the MRM assemblage and correspondingly lower frequencies on epiphyses is understandable considering the small sample of disarticulated small bovids in the actualistic assemblage. If more animals were disarticulated in the actualistic study, we may expect greater similarity in the distributions of cut marks in the two assemblages. It is surprising that cuts are absent from the proximal epiphysis and proximal shafts of humeri at KRM1, especially considering the high frequencies of cuts on scapulae, pelves, and femora. This may be due to preservational biases. Nevertheless, because the humerus is a meaty limb bone, we may expect higher proportions of cuts on the upper part of humeri. I am at present unable to explain this discrepancy adequately, but a defleshing strategy involving limited tool use and/or tool to bone contact is a possibility. The exaggerated proportion of cuts on the distal epiphyses of humeri may reflect better preservation of this portion and/or
disarticulation, and once more, the lower proportions of cuts on this anatomical portion in the MRM assemblage is due to the small sample of disarticulated animals. Cuts on distal humeri shafts certainly indicate filleting of this element. Excluding pelves, for reasons given above, the % MCFs on rear limbs are roughly the same at MRM and KRM1, particularly on meaty femora. Along with other data presented above, the distribution of % MCFs by element supports the interpretation that hominids gained early, if not full access to carcasses of small bovids, possibly through hunting.

Figure 6.11. Proportional distribution of MCFs per MNE across different anatomical portions by element on (a) front limb bones and (b) rear limb bones and ribs of small bovids from MRM (all cut marks) and KRM1.
6.3.3.3. A comparison of cut marks on large bovid bones from MRM and KRM1

First I compare the two assemblages according to MCFs, then the distribution of % MCFs across different anatomical portions of the skeleton, and finally the distribution of % MCFs across different anatomical portions by element.

Mann-Whitney U-Tests show that, when comparing KRM1 with the MRM filleted sample, and when comparing KRM1 with the MRM filleted and disarticulated sample, the MCFs are significantly different ($t_s = 3.1612, P < 0.01$ and $t_s = 3.2638, P < 0.01$ respectively). MRM large bovids retain significantly higher MCFs than bovids in size class IV from KRM1. According to the MRM observations, this suggests that hominids at KRM1 did not have full access to all parts of large bovid carcasses. This issue is discussed in more detail below when comparing the distribution of % MCFs at MRM and KRM1. Interestingly, a correlation analysis shows that the distribution of MCFs on large bovid bones from the two assemblages are significantly correlated ($r_s = 0.35, P < 0.05$). This suggests that while large bovids at KRM1 were not butchered as thoroughly as at MRM, the animals were processed in ways similar to those observed at MRM. The lack of thorough butchery, as indicated by lower cut mark frequencies at KRM1, suggests that hominids did not have full access to carcasses of large animals.

Examination of Figure 6.12 shows that MCFs are different between the assemblages at the following skeletal portions; scapula shaft, carpal bones, pelvis, and tarsals. The differences at these anatomical portions can be rationalized to some extent. As mentioned, bovids in size class IV were possibly not acquired with all the meat on the bones at KRM1, and therefore cuts are not as numerous as at MRM. Additionally, metal tools (MRM) may generate more cuts than stone tools (KRM1). Nevertheless, scapula shafts at KRM1 retain the highest MCF of all meaty limb bones, a pattern resembling that observed in the MRM assemblage. Relatively lower MCF on scapulae at KRM1 do not indicate late or lack of access to this element. The observation that scapulae retain the highest MCF of meaty limb bones suggests that hominids at KRM1 had early, if not full access to scapulae. In the discussion of small bovids above, I have reasoned why carpals and tarsals may retain different frequencies of cuts at MRM and KRM1 and suggest the same argument can be made for large bovids. The argument being that a different disarticulation strategy was employed at KRM1, probably largely due to the nature of stone tool technology. I have also explained the probable cause for low MCF on pelvis shafts, and this issue needs to be resolved before evaluating butchery and carcass acquisition strategies concerning pelves at...
KRM1. High MCF on acetabulae at KRM1, however, suggests that femora were consistently disarticulated from pelves.

Although Figure 6.12 shows that for skeletal elements not listed above, the two assemblages are not notably different, the paucity of cuts on femora at KRM1 warrant brief discussion (see Figure 6.12). Milo (1998: 105-107) has suggested that this pattern is consistent with stripping muscles from the rear limb as described by Frison (1974) and Gifford-Gonzalez (1998a). An alternative explanation for the paucity of cuts on femora is that KRM1 hominids did not have full access to this part. This suggestion is supported in part by the fact that, of the meaty limb bones (scapulae, humeri, pelves, and femora), femora retain the lowest number of cuts at KRM1. In the MRM assemblage, large bovid femora retain higher MCF than humeri. At KRM1, humeri retain higher MCF than femora. With respect to the carnivore consumption sequence (Blumenschine 1986a), the possibility of hominids acquiring carcasses after carnivores had eaten some meat from the rear quarters can not be ruled out. If low MCF on non-acetabular pelvis portions of size class IV bovids at KRM1 is confirmed, and not an artefact of the method used for calculating MNEs, then a scavenging scenario is a strong possibility. Until we resolve the problem in calculating MCFs for non-acetabular pelvis portions at KRM1, a more authoritative interpretation can not be offered. Regarding the overall pattern of MCFs at KRM1, hominids were at worst gaining access to some carcass parts relatively high (rib cage) and mediocre (humerus) in the carnivore flesh consumption sequence (Blumenschine 1986a). The presence of evisceration cuts on medial surfaces of rib shafts (Milo 1999 personal communication) suggests that hominids were gaining early access to some carcasses. But since the rib cage is placed after pelves and femora in the carnivore flesh consumption sequence (Blumenschine 1986a), it is critical that we resolve the pelvis dilemma in order to place the KRM1 hominids more accurately in the chain of large bovid meat eaters.
Concerning the proportional distribution of MCFs across different portions of the appendicular skeleton of large bovids at KRM1 and MRM, a correlation analysis shows that the two assemblages are significantly correlated ($r_s = 0.35$, $P < 0.05$). Overall, this implies that hominids at KRM1 employed strategies of butchery similar to those observed at MRM. Figure 6.13 shows that the proportional distribution of MCFs on large bovid bones from MRM and KRM1 are most different at the scapula shaft, carpal bones, pelvis, femur,
calcaneum, and ribs. Apart from ribs, I have already rationalized why the above-listed elements may account for the discrepancy between the MRM and KRM1 cut mark data. Note that ribs have a higher proportion of cut marks at KRM1 than at MRM and were clearly processed thoroughly and consistently at KRM1. The differences in the proportional distribution of MCFs from the two assemblages indicates that meaty limb bones such as the scapula, pelvis and femur did not receive the same attention from butchers at KRM1 as the less meaty bones such as the distal humerus, tarsals and ribs. Figure 6.13 shows that butchers at MRM invested proportionately more effort in the meaty bones (scapula, humerus, pelvis and femur) than the less meaty bones. This pattern strongly suggests that hominids at KRM1 did not have the same access to carcasses of large animals as the butchers at MRM. Hominids at KRM1 appear to have acquired carcasses of large animals after some meat had been consumed by non-hominid carnivores. This proposal is tentative, but is in part supported by the lower frequencies of cut marks at KRM1 relative to MRM, and requires testing or corroboration through resolving the calculation of MNE and MCF for non-acetabular pelvis portions. If non-acetabular pelvis portions indeed retain few cut marks and hominids were scavenging, they were doing so very actively and successfully, since they acquired elements relatively high (rib cage) and mediocre (humerus) in the carnivore flesh consumption sequence (Blumenschine 1986a). Hominids at KRM1 were apparently not the most marginal scavengers of large bovid carcasses (contra Binford 1984c). The cut mark evidence suggests that hominids at KRM1 were acquiring considerable amounts of meat probably most commonly through aggressive scavenging. Some hunting can not be ruled out entirely. It is conceivable that hominids were operating in cooperative and coordinated groups, and as Milo (1998) has suggested, this trait is at least part of the repertoire enjoyed by anatomically and behaviourally modern humans. Nevertheless, proof for such behaviour among hominids remains intangible.
Figure 6.13. Proportional distribution of MCF per MNE across different anatomical portions of the skeleton on (a) front and (b) rear limb bones and ribs of large bovid bones from MRM and KRM1.

Below I discuss and compare MRM and KRM1 in terms of the proportional distributions of MCFs across different anatomical portions by skeletal element. A correlation analysis reveals that the two assemblages are not significantly correlated in this regard ($r_s = 0.31$, $P > 0.05$). This result indicates that at the level of element and anatomical portion, butchers at the two sites were producing different proportions of cut marks. This observation may indicate
subtle differences in butchery technique, but such detailed interpretation requires larger and more varied comparative assemblages. Figure 6.14. shows that for the meaty bones of the front limb (scapulae and humeri), the % MCFs by element are almost identical for MRM and KRM1. This strongly suggests that butchers at KRM1 were gaining full access to front limbs of large animals and were processing them thoroughly. For reasons given above, the situation for the rear limbs is more complicated and therefore more authoritative interpretation must await resolution of methodological constraints. According to the cut mark data, there is no evidence suggesting that hominids at KRM1 were marginal scavengers of large bovids (*contra* Binford 1984c). In fact, there is strong evidence that KRM1 inhabitants were gaining early access to front limbs and rib cages of large bovid carcasses, probably through aggressive scavenging. Coordinated group activities were in all likelihood conducted by hominids at KRM1 and Milo discusses the implications of such group oriented activities with respect to behavioural modernity (1998: 124-126).

(a)

![Front Limbs: % MCF per element chart](chart_image)
Figure 6.14. Proportional distribution of MCF per MNE across different anatomical portions by element on (a) front and (b) rear limb bones and ribs of large bovid bones from MRM and KRM1.

The overall conclusions regarding carcass acquisition and butchery strategies practiced by hominids at KRM1 are based on the sum of the evidence presented above, and are as follows. 1) hominids were acquiring, at worst, nearly complete carcasses of small bovids and were processing them thoroughly; hunting and/or scavenging from tree-stored leopard kills are the most likely acquisition strategies. 2) hominids employed similar butchery strategies for processing small and large bovids, but do not appear to have had full access to carcasses of large animals; evidence for removing substantial quantities of meat from certain meaty bones suggests that hominids at KRM1 were practicing a form of aggressive scavenging in acquiring resources from large animals.

6.4. BUNN AND KROLL’S (1986, 1988b) INTERPRETATION OF CUT MARKED BONES FROM FLK ZINJANTHROPUS, OLDUVAI GORGE, TANZANIA

6.4.1. Introduction

Since early interpretations of hominid behaviour in the Plio-Pleistocene (e.g., Clark 1972; Dart 1957; Isaac 1971, 1977, 1978b; Leakey 1960; Leakey 1971) – predominantly based on the association of animal bones and stone artefacts – archaeologists and
Binford et al. 1988; Blumenschine 1995; Blumenschine & Marean 1993; Blumenschine & Selvaggio 1991; Marean & Spencer 1991; Selvaggio 1994, 1998). These studies demonstrated that carnivores destroy and delete bones from faunal assemblages, and that determining whether hominids acquired early or late access to animal carcasses can not be gauged by size, age, or skeletal part profiles (e.g., Binford 1984c; Blumenschine 1985, 1986a; Klein 1982; Potts 1983; Stiner 1991; Vrba 1980).

Due to the confounding effects of taphonomic processes on the nature of faunal assemblages, several researchers believe that cut marks on animal bones offer the strongest line of evidence of hominid involvement with animal carcasses (Behrensmeyer 1986; Binford 1981; Blumenschine 1988a; Blumenschine et al. 1996; Bunn 1983b; Bunn & Ezzo 1993; Bunn & Kroll 1986; Fisher 1995; Lupo 1994; Lyman 1987a, 1994b; Milo 1994, 1998; Potts 1984b; Shipman 1986a; Shipman & Rose 1983b). Cut marks and carnivore tooth marks on surfaces of animal bones have been used as diagnostic variables for reconstructing butchery and carcass acquisition strategies of hominids depositing cut marked bones at Plio-Pleistocene sites (e.g., Binford 1981, 1983, 1984c, 1988; Blumenschine 1988a; Blumenschine & Marean 1993; Bunn 1981, 1983b; Bunn & Kroll 1986; Oliver 1994; Potts 1983, 1984b; Potts & Shipman 1981; Selvaggio 1994, 1998; Shipman 1986a, 1986b).

Cut mark data from the site of FLK Zinjanthropus (FLK) are considered here because FLK was among the first of only a few early archaeological sites from which direct evidence for hominid involvement with animal carcasses was reported (Bunn 1981, 1982b, 1983b; Potts & Shipman 1981; Shipman 1983; Shipman & Rose 1983b). The site is significant because it provided the earliest, and critically debated evidence for hominids consuming animal products. Hominid strategies for acquiring animal products are discussed in more detail below, but whichever strategies were practiced, they in all likelihood demanded cooperative group foraging and communication skills (e.g., Ambrose 1986b; Ambrose & Lorenz 1990; Oliver 1994 and references therein; Schaller & Lowther 1969). This, according to Ambrose, required expansion of the brain, a feature present in Homo that emerged about 2 million years ago; around the time the cut marked bones were deposited at FLK. Ambrose posits that, in the landscape hominids occupied, the most appropriate diet for an enlarged brain came in the form of animal rather than vegetable products. McHenry and O’Brien (1986) point out that a significant dietary change apparently occurred about 2 million years ago. They argue that this is evidenced by the decreased molar size in Homo habilis compared with that observed in Australopithecines. According to McHenry and O’Brien, this reduction
in tooth size possibly indicates an increase in meat consumption on the part of *H. habilis* (McHenry and O’Brien 1986: 447). Principally, the debate concerning the cut marked bones from FLK centers on the amount of animal products consumed by hominids and strategies of carcass acquisition (e.g., Binford 1981, 1988; Blumenschine 1985, 1986a, 1986b, 1987; Bunn 1981, 1982b, 1983b; Bunn & Ezzo 1993; Bunn & Kroll 1986, 1988a, 1988b; Oliver 1994; Potts & Shipman 1981; Selvaggio 1998; Shipman 1983). In section 6.4.3 below, I demonstrate that hominids at FLK did eat more than scraps of meat, and that their strategy for acquiring animal products can not be judged as hunting or marginal scavenging. Before evaluating Bunn & Kroll’s (1986) interpretations of the cut marked bones from FLK, I discuss some aspects of their methods for recording and quantifying cut marks.

### 6.4.2. Issues concerning methods of recording and quantifying cut marks

Regarding the FLK cut mark data, Lyman (1994b: 310) notes that the data can be studied in various ways not attempted by researchers who have interpreted the cut marks. He suggests several alternative approaches to evaluate the cut mark data (Lyman 1994b: 310-314). Since I am primarily concerned with Bunn and Kroll’s interpretations, I briefly discuss a method and interpretation submitted by Lyman to which my data are relevant. Lyman demonstrates that the proportion of cut marked bones of small bovids is not statistically different from those of large bovids. This suggests to Lyman that “the carcasses of small bovids were butchered just as intensively as carcasses of large bovids” (1994b: 310). Results from the MRM study show that when small and large bovids were butchered in the same way (with the same intensity), large bovid bones retained significantly higher frequencies of cut marks than bones of small bovids ($U_s = 269.5, P < 0.001$). According to the MRM data, large bovid bones should retain significantly higher frequencies of cut marks than small bovid bones if the two size groups were butchered with the same intensity. This suggests that the number of cut marked bones is not necessarily a reliable indicator of differential butchery intensity on small and large animal bones because of differential fragmentation of small and large bovid bones. Conceivably, large bovid bones are more fragmented than those of small bovids (see Klein 1989b; Milo 1998) and therefore proportions of cut marked large animal bones will be reduced accordingly. Moreover, vis-à-vis the example of the humerus given below, even though the distal humerus may be represented by more cut marked pieces, the average number of cut marks on proximal humerus pieces may be higher than that on distal
humerus pieces. But, assuming that cut marked pieces for a given element or portion are roughly equal to frequencies of cuts per element or portion, then similar proportions of cut marked pieces of small and large bovid bones – according to my data – suggest that large bovids were not butchered as intensively as small bovids at FLK (contra Lyman 1994b).

Bunn and Kroll limit their analysis to bones that were studied microscopically. In the note at the bottom of Table 4 (1986: 437) however, they state that “the remainder of the macro-sample specimens have not been studied microscopically”. It is unclear, therefore, how they calculated percentages of cut marked pieces using the total number of pieces, but using only microscopically detected cut marks. Surely it is the cut marked sample detected by the macro-study that must be used to calculate the percentage. In addition, Bunn and Kroll do not relate how many of the total pieces of any element were examined microscopically. The text suggests that all pieces were examined microscopically (1986: 436).

Because Bunn and Kroll (1986, 1988a, 1988b) did not publish numbers of cut marks at various anatomical loci, but rather percentages of cut marked pieces, the data from my study are not immediately comparable with theirs. I recorded numbers of cut marks at different anatomical loci since it is believed that the numbers of cut marks are indicative of the amount of effort expended in butchery activities (e.g., Binford 1988; Milo 1998; Rapson 1990; personal observations; but also see Gifford-Gonzalez 1989a).

To compare the data from the MRM study with that presented by Bunn and Kroll (1986, Table 4), an assumption must be made. For example, in Table 4 (Bunn & Kroll 1986: 437), we see that 66.7% of distal humeri fragments (DSH) and 33.3% of proximal humeri fragments (PSH) were cut marked. I assume this means that, before fragmentation, the distal humerus portion had about twice as many cuts as the proximal humerus. Whether this assumption is realistic requires comparable publication of the FLK cut mark data as well as additional actualistic research into the effects of fragmentation on frequencies of cut marks and cut marked pieces at various anatomical loci. This may be achieved by fracturing the bones in the MRM assemblage and applying the technique used by Rapson (1990). Rapson (1990: 287) applies a method of counting numbers of “cut marks per unit area” that he believes “controls for differences in specimen size” and, which indicates the intensity of butchery activities. If the above-mentioned assumption does not hold, then a study of individual cuts can not be compared with one calculating percentages of cut pieces. Returning to the example of the humerus mentioned above, my concern is that the average number of cuts per cut marked piece for the proximal humerus might be 6, but for the distal humerus 3.
This indicates that more intensive cutting was taking place at the proximal end rather than the distal end, even though the distal end is represented by more cut marked pieces. Of course this raises important considerations for quantifying cut marks. It is the number of cut marks at anatomical locations that indicate butchery intensity (e.g., Binford 1988; Milo 1998; Rapson 1990; personal observations), and therefore I propose analysts tally cut marks as well as cut marked pieces. Doing both provides an opportunity to evaluate the relationship between numbers of cut marks and numbers of cut marked pieces for a given element or anatomical portion. Until actualistic data of this nature - evaluating the effects of fragmentation on cut mark frequencies - are available, I must assume that the number of cut marked pieces is roughly equal to the frequency of cut marks to compare the MRM and FLK cut mark data (Bunn & Kroll 1986, Table 4).

By standardizing Bunn and Kroll’s (1986, Table 4) percentages of cut marked pieces and my numbers of cut marks, several instructive comparisons can be made. Both data sets were standardised by calculating indices of the proportional distribution of cut marked pieces (FLK) and cut mark frequencies (MRM) at different anatomical portions by element and across all appendicular elements included in the current study. The following procedures were performed. For the FLK data, I summed Bunn and Kroll’s number of cut marked pieces per NISP for each element and then divided the number of cut marked pieces per NISP at a given anatomical location by the summed value for that element and multiplied the result by a hundred. Their percentages of cut marked pieces per anatomical portion are now modified into proportions of cut marked pieces at different anatomical locations by skeletal element. To calculate proportional frequencies of cut marked pieces per NISP at different anatomical portions with respect to the total number of cut marked pieces per NISP, the following procedure was performed. The number of cut marked pieces per NISP (cut pieces divided by the total number of pieces for that portion) for a given anatomical portion was divided by the sum of all cut marked pieces per NISP for all appendicular portions included in the current study. This value was then multiplied by a hundred to represent a proportion (percentage) of cut marked pieces at a given anatomical location of the total (100%) cut marked pieces. For the MRM data the same procedures were employed, but mean cut mark frequencies per MNE as opposed to cut marked pieces per NISP were used. These indices were used to generate bar graphs presented in section 6.4.3. The merit of this index is that it indicates which anatomical portions were more, or less intensively cut marked at the level of both portions by element and portions across the skeleton. Below I demonstrate that information of this nature is
critical to reconstructing butchery procedures and more importantly, for reconstructing carcass acquisition strategies. This theory is embellished and put into practice below in section 6.4.3.

Because Bunn and Kroll presented percentages of cut marked pieces at anatomical portions such as proximal epiphysis plus proximal shaft (PSH) and distal epiphysis plus distal shaft (DSH), I summed MRM cut mark frequencies at proximal epiphyses (PE) and proximal shafts (PS) as well as distal epiphyses (DE) and distal shafts (DS), making the two data sets comparable.

It is not clear what the values in Bunn and Kroll’s (1986, Table 4) columns titled ‘% of all cut-marked pieces’ are supposed to indicate. These values were calculated by dividing the number of cut marked pieces for a given anatomical portion by the total number of cut marked pieces, and then multiplying the result by a hundred. The values merely represent a proportion of cut marked pieces at a given anatomical portion of the total number of cut marked pieces. Because NISPs are not included in the formula, these values do not provide an index of the proportions with which cut marked pieces occur at different anatomical portions by element or across the skeleton. The common denominator should be the total number of cut marked pieces per total NISP and not the total number of cut marked pieces. I illustrate the predicament with the following example. Of small bovid tibia shaft fragments 30.6% are cut marked while 66.7% of distal tibia pieces are cut marked. In the ‘% of all cut-marked pieces’ column, however, the tibia shaft is represented by 22% (the highest of all elements) while distal tibiae are presented by 4% (second lowest of all elements). Consequently, it is not clear what this column is supposed to indicate. I propose that it is more constructive to calculate the proportions with which different anatomical portions are cut marked per MNE with respect to the overall incidence of cut marked pieces or frequencies of cut marks per total MNE. For that reason it is critical to include NISPs, MNIs or MNEs in the equation. MNEs for different anatomical portions should be calculated using pieces representing specific portions. Calculating MNEs for specific anatomical portions from overall representation of pieces for a given element may have a significant biasing effect due to differential fragmentation and preservation (e.g., Bartram 1993b; Marean & Spencer 1991; Milo 1994, 1998). The formula for calculating proportions of cut marked pieces and cut mark frequencies for various anatomical portions per element and across the skeleton is described above. Table 6.2 and Figures 6.15 and 6.16 display proportional distributions of cut marked pieces per MNE (FLK) and cut mark frequencies (filleted and
filleted and disarticulated samples are presented separately) per MNE (MRM) across different anatomical portions by element. Figures are provided to facilitate comparisons between the assemblages. Proportional distributions of cut marked pieces and cut mark frequencies (including all cut marks from the MRM assemblage) at anatomical portions by element and across the skeleton are presented in the figures in section 6.4.3 where FLK and MRM are compared.

Table 6.2. Proportional frequency distributions of cut marks and cut marked pieces at different anatomical loci by skeletal element. Values in the first FLK columns are from data for FLK *Zinjanthropus* (Bunn & Kroll 1986, Table 4, pp. 437). Values in MRM columns are derived from Tables 4.39 and 4.40. The filleted and disarticulated sample for small bovids is excluded due to sample size. Fill & dis = filleted and disarticulated sample, MCF = mean cut mark frequency per MNE (after Milo 1998).

<table>
<thead>
<tr>
<th>Element</th>
<th>Small Bovids</th>
<th>Filleting cuts</th>
<th>Large Bovids</th>
<th>Filleting cuts</th>
<th>Fill &amp; dis cuts</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All cut marks</td>
<td>FLK% of cut pieces</td>
<td>FLK% cut pieces</td>
<td>MRM% of cut pieces</td>
<td>MRM% cut pieces</td>
</tr>
<tr>
<td>Scapula</td>
<td>PSH 33.3</td>
<td>22.2</td>
<td>9.1</td>
<td>100.0</td>
<td>94.0</td>
</tr>
<tr>
<td>Radius</td>
<td>PSH 50.0</td>
<td>66.7</td>
<td>0.1</td>
<td>3.8</td>
<td>24.0</td>
</tr>
<tr>
<td>Pelvis</td>
<td>PSH 14.3</td>
<td>14.3</td>
<td>1.9</td>
<td>21.3</td>
<td>30.3</td>
</tr>
</tbody>
</table>

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Figure 6.15. Proportional frequency distribution of cut marks (a) and cut marked pieces (b) across different anatomical loci by element on small bovid bones. Values in (a) are from the MRM assemblage and values in (b) are derived from Bunn and Kroll’s (1986, Table 4) data for FLK Zinjanthropus.
Figure 6.16. Proportional frequency distribution of cut marks (a) and cut marked pieces (b) across different anatomical loci by skeletal element on large bovid bones. Values in (a) are from the current actualistic study (filleted sample on left and filleted and disarticulated sample on right) and values in (b) are derived from Bunn and Kroll’s (1986, Table 4) data for FLK Zinjanthropus.

An additional problem with the way Bunn and Kroll (1986) presented their data, is that it is not possible to determine MNEs for different skeletal portions by animal size class, although they argue that “If we used table 2 MNE values instead of table 4 number of
specimen values as a basis for calculating cut mark percentage values … [it would not affect] … the overall butchery patterns” (Bunn & Kroll 1986: 438). I assume that they have done this and that the butchery pattern did not change. The data provided in their Table 2, however, does not present MNEs for different animal size groups. As a result it is not possible to determine numbers of cut marked bones per MNE. Even though Oliver (1994) presents cut mark frequencies per MNE, these are for entire elements and not anatomical portions and are therefore not appropriate for the current study. Unfortunately, Oliver (1994) does not provide revised cut mark data for scapulae or pelves. Because scapulae are associated with large amounts of meat and because scapulae are uniquely placed in the carnivore consumption sequence, I demonstrate below that these elements are among the critical indicators of carcass acquisition strategies. In the current study, scapulae and pelves are considered as limb bone elements. A further concern regarding MNEs is that Bunn and Kroll do not tell us whether 4 cut marked pieces of distal humerus (DSH) represent one or four skeletal elements. Without this information it is not possible to calculate the number of cut marked elements or portions per MNE. I propose, therefore, it is more meaningful to calculate the number of cut marked pieces per NISP/MNE and frequencies of cut marks per MNE for different anatomical portions by element and across the skeleton (also see Bartram 1993a).

Concerning the anatomical portions Bunn and Kroll employed as indicators of carcass dismembering strategies, I return to results of comparisons between the exclusively filleted sample and the filleted and disarticulated sample from the MRM study (see section 4.5.5 for more details). Results from Mann-Whitney U-Tests (Sokal & Rohlf 1981) demonstrate that when PSH and DSH (as used by Bunn and Kroll as areas of disarticulation) are used to compare the filleted only and filleted and disarticulated samples from MRM, there is not a significant difference between the two samples ($U_s = 62.5, P > 0.1$). Even when a combination of proximal shafts and distal shafts is used to compare the filleted sample with that produced by filleting and disarticulation, the samples are not significantly different in terms of cut mark frequencies ($U_s = 90.0, P > 0.1$). As expected, when comparing frequencies of cut marks on mid shafts between the filleted and filleted and disarticulated samples, there is not a significant difference (see section 4.5.5). Nevertheless, when comparing cut mark frequencies at epiphyses, the filleted and disarticulated sample retains significantly more cut marks per butchered epiphysis than the sample produced exclusively by filleting ($U_s = 68.0,$
The results show that it is only on epiphyses that cut mark frequencies vary according to the butchery procedure employed.

Consequently, from a methodological perspective, the reliance on near epiphyseal (like those on PSH and DSH portions as used by Bunn and Kroll) cut marks as indicators of carcass dismemberment is questioned. This substantiates the MRM data on anatomical placement of cut marks, which show that some cut marks on and near epiphyses result from either filleting, disarticulation, or a combination of the two processes. Moreover, as I have described in section 5.4.9, 62% of Binford’s (1981) cut mark locations coded as unambiguous indicators of limb bone dismemberment were produced when animals were exclusively filleted in the MRM study. Employing certain cut mark locations defined by Binford as unambiguous indicators of carcass dismemberment – but which were produced by filleting exclusively in the MRM study - is therefore problematic.

I have only used large bovids in comparisons between the filleted exclusively sample and that produced by a combination of filleting and disarticulation during the MRM study, since only one small bovid was filleted and disarticulated. Bear in mind that the MRM filleted and disarticulated sample was produced by disarticulating bones with all meat still attached. Consequently, the joints were held firmly by meat and connective tissues and were not visible to the butcher while he made his cuts. As a result, frequencies of cut marks at epiphyses are likely inflated in this sample since fewer marks are likely to be produced when disarticulating bones after the meat has been removed (personal observations; also see Binford 1988; Milo 1994, 1998). Once cleaned of meat, joints are looser and articulating regions clearly visible to the butcher. Cuts can be made directly to joints and between articular surfaces after bones are defleshed (personal observations; also see Binford 1988). Ideally, an actualistic sample of bones disarticulated before and after defleshing is required (e.g., Binford 1988; Milo 1994, 1998). Nevertheless, results show that disarticulation does affect the frequencies of cut marks at epiphyses (when all epiphyses are lumped), at least when disarticulating bones that are fully fleshed.

It follows that the proportions of cut mark frequencies across different anatomical portions for a given skeletal element and across the skeleton will vary depending on the butchery procedures employed. The latter, as explained above, is influenced largely by the availability of flesh when butchers acquire carcasses. For example, if butchers were filleting bones prior to disarticulation, we can expect to observe cut mark frequency distributions leaning toward a filleting exclusively pattern (see Table 6.2). This assumes that fewer cut
marks will be produced when disarticulating previously defleshed bones. In this scenario, with proportionately lower frequencies of cut marks at epiphyses (compared to the filleted and disarticulated sample), I argue that we then turn to identifying cut marks unambiguously associated with disarticulation to establish whether bones were disarticulated after filleting. In contrast, if butchers were disarticulating fully fleshed bones, we can expect to see a pattern similar to that presented in the filleted and disarticulated columns of Table 6.2 and the proportional distribution of cut marks for the filleted and disarticulated sample in Figure 6.16.

Results from the MRM study show that cut mark frequencies on limb bone shafts (including near epiphyseal portions) are not affected by disparate butchery strategies (see statistic above). Whether bones are filleted exclusively, or filleted and disarticulated, shafts are prone to accrue cut marks. Of course the total absence of cut marks on shafts would indicate non-filleting, or less likely, the removal of meat by a process not impacting bone surfaces.

In analysing and interpreting cut marks with the aim of reconstructing butchery and carcass acquisition strategies, I propose the use of a combination of unambiguous cut marks, proportional distributions of cut mark frequencies across different anatomical portions for a given skeletal element, and across different anatomical loci of the skeleton. This combination should provide corroborative evidence for either full, early, or late access to animal carcasses on the part of hominids in the Upper Pleistocene and Plio-Pleistocene. The three categories of data provide both cross-checks and an essential combination for separating the two butchery processes described above, as well as a sound foundation for determining the nature of carcass acquisition strategies. The above-mentioned categories of data should be evaluated and interpreted with respect to the carnivore consumption sequence (Blumenschine 1986a) and utility indices (e.g., Binford 1978; Blumenschine & Caro 1986). Below I demonstrate the interpretative potential of using this strategy in reconstructing butchery and carcass acquisition strategies.

Additional biasing processes need to be taken into account when calculating frequencies of cut marks. The effects of fragmentation have been mentioned above, and in this study this biasing effect is not an issue since bones are unfragmented. Nevertheless, cut mark frequencies have been expressed as cut marks per butchered element and portion (MNE) with the aim of making these data comparable to zooarchaeological assemblages. Similarly, Milo (1998) has partly resolved the biasing effect of fragmentation by calculating mean cut mark frequencies (MCF) per MNI by element and portion. Due to differential survival of bone
surfaces, analysts should exclude bones when their cortical and external surfaces are damaged, weathered, or exfoliated. Such bones may have retained cut marks that, through taphonomic processes, have become invisible, and therefore these specimens can not be included in tallying MNEs for either elements or portions. Clearly their inclusion would reduce cut mark frequencies.

6.4.3. Reconstructing butchery and carcass acquisition strategies practised by hominids at FLK *Zinjanthropus*

I concentrate on interpretations of cut marked bones from FLK offered by Bunn and Kroll (1986, 1988b). Additional comments on, and interpretations of the cut marked bones are referred to if they stimulate enhanced methodological approaches and interpretative frameworks. I do not delve into the legendary debate regarding the merits of various interpretations (but see Binford 1981, 1988 and Comments, Reply, and references cited; and Bunn & Kroll 1986, 1988b and Comments, Reply, and references cited; also see references in Oliver 1994 and Selvaggio 1998). Instead, I focus on the implications of the MRM study on Bunn and Kroll’s interpretations (and others where appropriate), and offer - with support from actualistic data collected during the MRM study - alternative interpretations of the cut mark data from FLK. Implications of the MRM study are also applicable to analyses and interpretations of cut marked bones from most prehistoric archaeological sites.

First I summarise Bunn and Kroll’s (1986) key interpretations and the principles they are founded on. Then I provide detailed examination of their interpretations and the supporting evidence. Based on cut mark data from the MRM study, information on the carnivore consumption sequence (Blumenschine 1986a) and utility indices (Blumenschine & Caro 1986), specific issues and interpretations are summarized and critiqued, and where possible, I offer alternative and occasionally more detailed interpretations of the cut mark data from FLK. I focus on cut marked bones from the appendicular skeleton, but exclude carpals, tarsals, metapodials, and extremities.

Referring to cut marked bones from FLK, Bunn and Kroll state that “… the locations and frequencies of cut marks on different skeletal parts can be directly linked to the skinning, disarticulation, and defleshing of carcasses” (1986: 432). They continue, “Recent ethnoarchaeological and experimental research (e.g., Binford 1978, 1981) has provided informative details on the links between some carcass-processing operations and the form and
placement of cut marks on some skeletal parts. Cut marks on non-meaty skin-covered bone surfaces, on or near epiphyses [my emphasis] where connective tissues bind articulating joints, and on meaty bones at points of muscle attachment can provide unambiguous [my emphasis] documentation of carcass skinning, joint disarticulation, and defleshing, respectively. … The cut marks are located in places that make anatomical sense relative to butchery requirements (Binford 1981; Bunn 1985) …” (Bunn & Kroll 1986: 436).

Bunn and Kroll refer to the overall placement of cut marks and their associated functions. As I have described in detail above, the anatomical placement of cut marks in the MRM assemblage reveals that when animals were exclusively filleted, cut marks were produced on and near epiphyses. This observation is supported by analyses of the frequencies of cut marks across different anatomical loci. With respect to the near joint zone (PSH and DSH as used by Bunn and Kroll 1986), statistical analysis shows that the frequencies of cut marks produced by filleting on the one hand, and filleting and disarticulation on the other are not significantly different (see section 6.4.2 for results of Mann-Whitney U-Tests). Along with anatomical placement data, this demonstrates that cut marks on near-joint anatomical portions do not unambiguously document disarticulation and can not be utilized to differentiate between filleting and disarticulation. Concerning epiphyseal portions (PE and DE as used in the MRM study), cut mark frequency data from the MRM study indicates that filleting alone (and possibly filleting prior to disarticulation) produces significantly lower frequencies of cut marks on epiphyseal portions than a combination of filleting and disarticulation.

As described in detail above and in chapter 5, when animals were filleted exclusively in the MRM study, cut marks were created at locations previously associated with disarticulation. Data from the MRM study demonstrate that more than 62% of Binford’s unambiguous disarticulation cut mark codes related to appendicular elements are in fact ambiguous. I propose, therefore, that the use of Binford’s (1981) behavioural correlates for reconstructing butchery procedures be restricted to those cut mark codes which have not proved to be ambiguous behavioural indicators through the MRM study. Near joint and epiphyseal cut marks are not unambiguous indicators of disarticulation (but see Table 4.37 for list of unambiguous cut mark codes established during the MRM study). Mid shaft cuts, however, were only produced by filleting and/or skinning in the MRM study. Below I demonstrate that the anatomical placement of cut marks used in isolation from cut mark
frequency data do not provide adequate evidence for reconstructing butchery procedures or carcass acquisition strategies.

Bunn and Kroll note that “Cut marks are concentrated on the meaty limbs of both smaller and larger animal carcasses. Sixty-two percent of all cut-marked bone specimens from smaller animals and 39.2% of all cut-marked specimens from larger animals are from the meaty limb bones” (1986: 436). Bunn and Kroll do not define meaty limb bones. They note that the large majority of cut marks on meaty bones are located on the mid shaft rather than the proximal or distal shafts and on epiphyses. “From the abundant cut marks on meaty limbs, all indications are that hominids at the FLK Zinjanthropus site had access to carcass portions with substantial quantities of meat attached and were cutting large quantities of meat from the bones” (Bunn and Kroll 1986: 437-438).

Figure 6.18 below shows that the highest proportions of cut marked appendicular bones on both small and large animals from FLK are on the distal humerus and distal tibia. The distal humerus is at the distal extreme of the meatiest part of the front limbs while the distal tibia is associated with the smallest quantities of meat on rear limbs (Blumenschine & Caro 1986: 328; personal observations). Scapulae and pelves are largely excluded from the discussion because Bunn and Kroll do not provide data regarding the location of cut marks on either the shafts or epiphyseal portions (distal ends of scapulae and acetabulae of pelves) of these elements. Below I discuss the proportional distribution of cut marked pieces on appendicular bones of small and large animals from FLK separately, starting with small animals.

Figure 6.18 shows that, excluding scapulae and pelves, the highest proportions of cut marked pieces on small bovid bones are on the distal humerus and distal tibia. Above I mentioned where these parts rank in terms of the meatiest parts of limbs (Blumenschine and Caro 1986; personal observations). Additionally, joints associated with these portions are also among the tightest for limb bones (Hill 1979a, 1979b). The second highest proportions of cut marked portions are the proximal radius and distal femur. The former is at the distal extreme of the meatiest part of the front limb, and is the least meaty appendicular element (Blumenschine & Caro 1986) while the latter is at the distal extreme of the meatiest part of the rear limb. The third highest cut marked portion is the proximal humerus. This portion is certainly among the meatiest elements of the front limb, yet the humerus ranks just above the tibia with respect to meat distribution on the appendicular skeleton (Blumenschine & Caro 1986). As discussed previously, cuts at the proximal humerus may be associated with either
filleting or disarticulation. Consequently, cuts at this location can not be employed in support of an argument for the consumption of large quantities of meat. The fourth highest proportion of cut marked pieces is on the tibia shaft. As mentioned, this portion is at the distal extreme of the meatiest part of the rear limb and ranks second lowest in terms of meat distribution on the appendicular skeleton (Blumenschine & Caro 1986). Roughly tied as the fifth highest portions of cut marked pieces are the radius shaft, humerus shaft, and proximal tibia. Radio-ulna ranks the lowest of appendicular elements in terms of meat distribution (Blumenschine & Caro 1986). By contrast, the humerus is associated with more meat than the radio-ulna but ranks as the lowest meat carrier of the upper limb bones (scapula, humerus, pelvis, and femur) (Blumenschine & Caro 1986). Proximal tibiae are at the distal end of the meaty part of rear limbs and, as mentioned before, cut marks at this location can not always be attributed to filleting nor disarticulation exclusively. The smallest proportion of cut marks are located on the femur shaft, an area associated with the largest amounts of meat on the appendicular skeleton (Blumenschine & Caro 1986).

The above discussion demonstrates that, apart from cut marked humeri fragments, – representing an area associated with less meat than the femur, pelvis, and scapula - the proportions of cut marked pieces of small animal appendicular bones are concentrated on bones associated with small quantities of meat. Inflated proportions of cut marked pieces at epiphyses of humeri, radii, distal femora, and distal tibiae, suggest that considerable emphasis was placed on disarticulation. This suggestion is supported above where I demonstrated that cut mark frequencies at epiphyses become inflated when animals in the MRM study were filleted and disarticulated. Cut marks are not concentrated on mid shafts rather than proximal and distal ends (contra Bunn & Kroll 1986). In fact, Figure 6.18 shows that the four highest proportions of cut marked pieces from FLK are on the distal humerus, distal tibia, proximal radius, and distal femur. With regard to small animals, Bunn and Kroll’s interpretation of hominid access to substantial amounts of meat and hominids removing a large amount of meat from bones is seriously questioned. Unfortunately Bunn and Kroll did not publish cut mark data for different portions of scapulae and pelves (among the meatiest appendicular bones). Without these data any interpretation remains provisional. Nevertheless, the fact that these two elements retain among the highest frequencies of cut marks in the MRM assemblage, and that they do not in the FLK assemblage, suggests that hominids did not have access to these elements when still fully fleshed. The latter proposition is substantiated below. As discussed above, hominids were apparently concentrating their butchery efforts on
the less meaty portions of limb bones of small animals. The greatest intensity of cutting was
taking place at epiphyseal portions. Apparently, for hominids depositing the cut marked
bones at FLK, disarticulation required more attention than filleting. It is questionable that
hominids were consuming large amounts of meat. More importantly, hominids do not appear
to have had full or even early access to the carcasses of small animals. It appears improbable
that hominids successfully hunted small animals. If they were successfully hunting small
animals, they were apparently not able to prevent non-hominid carnivores from consuming
large quantities of meat from these carcasses before gaining access to them. Nonetheless, the
fact that hominids were removing some flesh and disarticulating bones, indicates that they
gained access to carcasses before bones were entirely cleaned of meat and ravaged by non-
hominid scavengers \textit{(contra} Binford 1988; see Oliver 1994; Selvaggio 1998).

I now discuss the proportional distribution of cut marked pieces across different
anatomical portions of appendicular elements of large animals from FLK. I remind the reader
that Bunn and Kroll (1986) noted that cut marks were concentrated on meaty limb bones and
that cuts on meaty limb bones were concentrated on shafts rather than proximal and distal
ends. They interpreted this as indicative of hominids gaining access to substantial amounts of
meat and cutting large amounts of meat from the bones of large animals at FLK before
substantial amounts of meat was consumed by non-hominid carnivores. For reasons
mentioned above in the discussion of small animals, scapulae and pelves are largely excluded
from the following discussion. I stress again, however, that scapulae and pelves retained
amongst the highest frequencies of cut marks of all appendicular elements in the MRM
assemblage. In fact, scapulae retained the highest cut mark frequencies of all skeletal
elements. In the FLK assemblage they do not, and for reasons given above and below, this
suggests that hominids did not have access to these elements when fully fleshed.

As for small bovids, Figure 6.18 shows that the highest proportions of cut marked pieces
of appendicular bones are on the distal humerus and distal tibia. While the distal humerus is
at the distal end of the meatiest part of the front limb and ranks lowest of upper limb bones in
terms of meat distribution (e.g., Blumenschine & Caro 1986), cut marks at this location
cannot always be attributed to a single activity. Inflated frequencies of cut marked pieces of
this portion suggest an emphasis on disarticulation. On the other hand, distal tibiae are among
the least meaty bones of the rear limb. Tied roughly as the second highest proportions of cut
marked pieces are the radius shaft, proximal radius, and proximal ulna. All these portions are
at the distal end of the meatiest part of front limbs and rank the lowest in terms of meat
Very small quantities of meat are associated with radius shafts. Again, cuts at proximal radii and ulnae can not be attributed to a single butchery activity, and as argued elsewhere, inflated cut mark frequencies at epiphyses were produced when bones were filleted and disarticulated in the MRM study. The third highest proportions of cut marked pieces occur on the humerus shaft, distal radius, proximal femur, and femur shaft. While cut marks on humeri and femora shafts are certainly indicative of removing at least some meat from these elements, cuts on the distal radius and proximal femur can not always be attributed to a single activity. The lowest proportions of cut marked pieces are on ulna and tibia shafts. The highest proportions of cut marked pieces are not on femora and pelves, the meatiest limb bones (contra Bunn & Kroll 1986: 436). The highest proportion of mid shaft cut marks is on the radius, the least meaty bone of the appendicular skeleton. As was observed for small bovids, the highest concentrations of cut marked pieces of large bovid bones are not on shafts but on the distal humerus and distal tibiae (contra Bunn & Kroll 1986).

The above discussion does not support the interpretation of hominids gaining access to substantial amounts of meat or cutting large amounts of meat from the bones of large animals at FLK. Rather, based on the intensity of butchery at different anatomical portions as reflected by proportions of cut marked pieces, hominids were expending considerable effort disarticulating elbow and ankle joints. This suggestion, however, is tempered by the fact that the elbow and ankle joints are tight and require more effort to disarticulate than looser joints such as the knee and shoulder (personal observations; see for example Binford 1981, 1988; Hill 1979a, 1979b; Lyman 1994b; Milo 1994). Nevertheless, the higher proportion of cut marks on radius shaft pieces compared with humerus and femur shaft pieces indicates that more effort was expended removing meat from radii than from femora or humeri. Bear in mind that radio-ulnae rank the lowest of meat carrying appendicular elements (Blumenschine & Caro 1986). This suggests that hominids gained access to carcasses of large animals when more meat was available on radii than on humeri and femora. A scenario is envisaged where non-hominid carnivores consumed considerable quantities of meat from carcasses before hominids gained access to them (Blumenschine 1986a, 1986c). This suggestion is supported with data from the MRM study, where filleting produced higher frequencies of cut marks on femora and humeri than on radii. Moreover, as alluded to above, the fact that scapulae and pelves from FLK do not retain the highest or at least higher proportions of cut marked pieces (as can be expected from the MRM study), strongly suggests that these elements were not
fully fleshed when hominids gained access to carcasses of large animals. Hominids apparently did not have full access to carcasses, but seem to have disarticulated bones and cut some meat from bones after substantial amounts of meat were consumed by non-hominid carnivores. As with small animals, hominids apparently gained access to carcasses of large animals before bones were defleshed entirely and ravaged by non-hominid carnivores and scavengers. This is supported by the observation that the proportional distribution of cut marks on appendicular bones below the humerus and femur are not notably different from that recorded at MRM. Hunting seems an unlikely strategy for acquiring meat and other animal tissues if hominids were forced from carcasses by non-hominid carnivores, and only regained access to carcasses after considerable amounts of tissues were consumed by these adversaries. Secondary access, as evidenced by the cut mark data, may have involved active scavenging after successful non-hominid hunters had consumed tissues from bones high on the carnivore consumption sequence (Blumenschine 1986a).

Bunn and Kroll argue that “The somewhat lower percentage of cut marks on meaty limbs of larger animals (51.3% ...) relative to smaller animals (72%) does not indicate different access to or handling of the meat from the limbs of large animals. Because more usable meat occurs on the non-limb portions of large animals than on those of smaller animals, a higher percentage of cut marks on non-limb portions and a correspondingly lower percentage of cut marks on limb portions of large animals may be expected. This relationship is shown quite clearly by the higher cut mark percentages for ribs, vertebrae, and pelvis in larger than in smaller animals” (1986: 438). Before presenting a critique of their interpretation, I make a few points concerning these statements. First, the percentages of cut marked meaty bones of small and large animals given here differ from those given on page 436 of their paper. Second, Blumenschine and Caro’s (1986) utility indices show that almost identical proportions of meat occur on non-limb portions (about 50%) of both small and large animals. Large bovids do not have proportionately more meat on axial elements than small bovids (for reference to inter-species variation in meat distribution see Binford 1988). Bunn and Kroll’s principle is therefore questioned. Third, disregarding the merit of this principle for the moment, they state that certain percentages of cut marks may be expected. We can not, however, anticipate patterning without comparative experimental assemblages against which expectations can be gauged. Apparently their expectation is based on the notion that in comparison to small animals, more meat occurs on large bovid non-limb portions than limb portions. Clearly such expectations are problematic (e.g., Blumenschine & Caro 1986), but
actualistic data presented here can be used as a starting point to test expectations such as those put forward by Bunn and Kroll (1986: 438). Their suggested relationship is not based on actualistic data and is unsubstantiated. I support this statement below with cut mark data from MRM.

The MRM data shows that for large bovids, cut mark frequencies for pelves (which are considered as meaty limb elements in this study), femora, and scapulae, are higher than cut mark frequencies for ribs, lumbar, thoracic, and cervical vertebrae. Similarly, cut mark frequencies for humeri are higher than those for ribs and thoracic vertebrae, roughly the same as lumbar vertebrae, and slightly lower than cervical vertebrae. The MRM data indicate that cut mark frequencies on meaty non-limb portions are not higher than on meaty limb bone portions, which supports an argument against the relationship suggested by Bunn and Kroll. The MRM study demonstrates that when processed with the same intensity, meaty limb bones of large bovids retain significantly higher frequencies of cut marks than small bovids. Higher percentages of cut marked pieces on limb bones of small than large animal bones from FLK suggest that hominids gained differential access to different size animal carcasses and/or that the two size groups were butchered differently.

Bunn and Kroll (1986: 438) suggest that cut marks at specific anatomical locations provide evidence of “specific butchery operations and overall butchery practices”. Their interpretations of cut marks are based on Binford’s (1981) behavioural correlates, but as Lyman (1987a, 1987b, 1994b) has pointed out, “While Binford (1981) provided a functional typology for cut marks based on 108 anatomical locations and orientations [emphasis in original] of such marks, the general near-joint category of marks, for example, includes not just disarticulation marks but defleshing and skinning marks as well (Figure 8.2)” (Lyman 1994b: 309). Note that Lyman includes defleshing where he refers to metapodials, but no flesh is associated with this element (e.g., Blumenschine & Caro 1986; personal observation).

Bunn and Kroll describe the clustering of cut marks on certain skeletal elements of smaller animal bones. They suggest that most of these cut marks relate to filleting. Included in their list of elements is the metacarpal shaft. As mentioned above, however, no meat is associated with metapodials and therefore cut marks on metapodial shafts can not be linked to filleting (personal observations).

Bunn and Kroll refer to specific cut mark locations and their associated functions. Here I mention a few which are discussed in more detail below. “Repeated dismemberment of the
elbow joint is documented by cut marks on the distal humerus and the proximal radio-ulna. Figure 4 shows … cut marks that are equivalent to Binford’s (1981: 123) cut marks labeled Hd-2. … Other rarer but unequivocal examples of carcass dismemberment … involving dismemberment of the scapula (Binford 1981: 122, cut mark labeled S-1), [and] the femur (Binford 1981: 117, cut mark labeled Fp-5)” (Bunn & Kroll 1986: 438-439). Numerous cut marks were recorded on areas of muscle attachment on meaty limb bones. Again, meaty limb bones are not defined.

Using Binford’s (1978, 1981) behavioural correlates, cut marks located at specific anatomical locations on bones from FLK are interpreted by Bunn and Kroll (1986) as unequivocal documentation of carcass dismemberment. Chapter 5 of this dissertation is dedicated to a comprehensive discussion of Binford’s cut mark codes and behavioural correlates as well as the implications of the MRM study on the merit of Binford’s (1981) frame of reference. Bunn and Kroll’s interpretation of cut mark placement is also based, in part, on cut marked animal bones butchered by Bunn (1985). Where analysts perform their own butchery and then examine the bones for cut marks (e.g., Bunn 1985; Gifford-Gonzalez 1989a; Milo 1994, 1998), the unconscious expression of research biases and lack of butchery experience is a concern. Selvaggio (1994, 1998: 194) has argued, however, that during experimental butchery, different butchers did not produce significantly different frequencies of cut marks. Further actualistic studies are needed to determine whether analysts performing their own butchery have an effect on the anatomical placement of cut marks, and the proportional distribution of cut mark frequencies across different anatomical portions.

Highlighted here are a few specific anatomical locations where the MRM data are directly relevant to Bunn and Kroll’s interpretations. They interpret cut marks located on the distal humerus (Binford 1981: 123 cut mark labeled Hd-2), distal scapula (Binford 1981: 122 cut mark labeled S-1), and proximal femur (Binford 1981: 117 cut mark labeled Fp-5) as unambiguous documentation of carcass dismemberment (Bunn & Kroll 1986: 438-439). Concerning cut Hd-2 on the distal humerus, Bunn and Kroll infer repetitive disarticulation of the humerus and radio-ulna joint by hominids depositing cut marked bones at FLK. Figure 4.257 displays cut marks produced when animals were filleted exclusively during the MRM study. Cut marks labeled Hd-2 were commonly produced during filleting and consequently, cuts at this location are not unambiguous indicators of carcass dismemberment. Additionally, cuts at this location are also produced when fresh carcasses, stiffened through rigor-mortis, are butchered (Lupo 1994). Cuts labeled Hd-2, therefore, do not necessarily document
dismemberment of stiff and desiccated carcasses (*contra* Binford 1981, 1984c, 1986, 1988). Similarly, cut marks on scapulae (labeled S-1 & S-2) and proximal femora (labeled Fp-5) were produced when animals were *filleted exclusively* during the MRM study (Figures 4.254 and 4.267 respectively). Consequently, cut marks at these anatomical loci are *dubious* indicators of carcass dismemberment. Binford’s (1981) frame of reference is seriously questioned and I propose that, when interpreting cut mark placement to reconstruct butchery procedures, cut mark locations are employed that are not proved ambiguous by the MRM observations (see Tables 4.37 and 5.1).

Bunn and Kroll (1986) interpret the frequency distribution of cut marked pieces at different anatomical locations as indicative of thorough and systematic butchery of small and large bovids. “Our analysis reveals that ancient hominids had *full* [my emphasis] access to meaty carcasses of many small and large animals prior to any substantial loss of meat or marrow bones through predator or scavenger feeding … and the prevalence of defleshing cut marks on these [meaty limb] bones contradict the suggestion that meat and/or marrow acquisition by ancient hominids resulted primarily from scavenging from abandoned predator (and particularly lion) kills” (Bunn & Kroll 1986: 439 and 441). In contrast, Binford (1988) argues that high frequencies of cut marks are indicative of increased effort in removing all tissues from bones, and conversely, that lower frequencies of cut marks indicate less effort to deflesh bones completely. Binford (1988) and Bunn and Kroll (1988b) debate this matter at length. In reply, Bunn and Kroll (1988b) point out that the frequencies of cut marks on the Olduvai bones are similar to those recorded at Neolithic sites where it is likely that people had access to considerable quantities of meat (for example see Marshall 1986).

Bear in mind that Marshall (1986) used Bunn and Kroll’s macroscopically detected cut marks in tabulating the cut mark data she presents. The frequencies of cut marked bones are sometimes lower when the microscopically detected specimens are used for the FLK assemblage. Nevertheless, the overall frequencies of cut marked pieces may be similar at FLK and the Neolithic site. Examination of Table 2 in Marshall’s (1986) paper, however, reveals at least one critical difference between the Ngamuriak and FLK cut mark data.

I focus on cut marked scapulae for the following reasons: scapulae are the most intensively cut marked bones in the MRM assemblage (because much meat is associated with this element and because its morphological structure causes the butcher to make considerable tool to bone contact); scapulae rank fairly low in the carnivore consumption sequence and should therefore be fleshed if hominids were acquiring carcasses relatively early
(Blumenschine 1986a, 1986c; but see Gifford-Gonzalez 1989a); and scapulae are associated with considerable quantities of meat (Blumenschine & Caro 1986). Anatomically, scapulae are in a unique position as they contain the highest quantity of meat on the front limb, but because scapulae are attached to, and lie flat against the thorax, carnivores apparently find it easier to feed from the humerus before the scapula. Although humeri are associated with less flesh than scapulae (Blumenschine & Caro 1986), carnivores deflesh humeri before scapulae (Blumenschine 1986a). Based on these facts, we can expect that hominids gaining relatively early access to scapulae (because they rank fairly low in the carnivore consumption sequence) should leave considerable numbers of cut marks (because there is a lot of meat and because scapulae accrue many cut marks) if they were removing large amounts of meat from scapulae. For the time being, let us ignore the fragmentation predicament alluded to above, but remember that Bunn and Kroll (1986, Table 4) do not provide separate data for scapula shafts and epiphyses, and we must therefore entertain the possibility that at least some scapula cuts are disarticulation cuts. Especially since one of their figures displays an alleged disarticulation cut and since high proportions of cuts are located at ends of bones. The actual proportion of filleting cuts is, therefore, probably lower than the percentages given below.

At Ngamuriak, where access to carcasses is apparently not an issue, we see that 46.2% of large bovid scapula specimens retain cut marks (Marshall 1986, Table 2). By contrast, at FLK only 13.6% (or 9.1% microscopically detected) of large animal scapula specimens retain cut marks and cuts are entirely absent on scapulae of small animals. Again, I stress that scapulae retained higher cut mark frequencies than any other skeletal element in the MRM assemblage for both small and large bovids. Binford (1988) showed that scapulae also retained the highest frequencies of cut marks at the Bugas-Holding site. In addition, brief examination of cut mark frequencies per MNE presented by Bartram (1993a: 392-422) reveal that scapulae retain higher cut mark frequencies than any other skeletal element at several (about 44%) of the Kua San ethnoarchaeological sites. Note that some carcasses were actually scavenged by the Kua San (Bartram 1993a). For scapulae, there is a marked difference between the frequency of cut marked specimens at Ngamuriak and FLK. Scapulae are cut marked more than three times as frequently at Ngamuriak than at FLK. High frequencies of cut marked scapulae at Ngamuriak is not very different from that observed at Bugas-Holding (despite the anticipated effects of climatic variation as discussed by Bunn and Kroll [1988b]) and Kua San ethnoarchaeological sites. With the exception of FLK, sites referred to above, as well as the Middle Stone Age site of Klasies River Mouth (Milo 1998) discussed in more detail.
above in section 6.3, show high incidence of cutting on scapulae. This is remarkably similar to the high incidence of cutting documented on scapulae in the actualistic assemblage from MRM.

The above discussion demonstrates that at a wide range of sites, scapulae are regularly cut marked, regardless of variation in cultural practices, kinds of butchery tools, butcher’s skill or strength, climatic conditions, context and purpose of butchery, condition of carcass when butchered, transport considerations, and preservation and fragmentation of bones. At least for scapulae, this finding demonstrates that cut mark data from faunal assemblages varying considerably in aspects just mentioned can be meaningfully compared (contra Bunn & Kroll 1988b: 147). Based on the MRM data and on results from comparisons made between MRM, FLK, and KRM1, there may be a hundred ways to skin a cat, but apparently there are not a hundred ways to deflesh one. Regardless of the variables mentioned above, when people or hominids have access to elements when fleshted, they create similar proportions of cut marks across different anatomical portions. This hypothesis is substantiated below.

In my opinion, the preceding discussion presents compelling evidence that hominids at FLK did not find scapulae with much meat attached. The low incidence of cut marked scapulae at FLK can not be attributed to boiling technology as evidence for boiling is absent at FLK. Significantly, the frequency of cut marked scapulae at FLK is different from that observed in all assemblages referred to above, and despite anticipated variation in culinary practices (Fiorillo 1989; Gifford-Gonzalez 1989a, 1989b, 1993; Oliver 1993; Yellen 1977b, 1991a), assemblages other than FLK display comparable frequencies of cut marked scapulae. The suggestion that considerable amounts of meat was consumed by non-hominid carnivores before hominids acquired scapulae (Blumenschine 1985, 1986c, 1987; contra Bunn & Ezzo 1993) is consistent with the cut mark evidence presented here. Blumenschine stated that various alternative carcass acquisition strategies could not be tested because “experiments [were] clearly needed to distinguish between cut marks inflicted for defleshing versus disarticulation, and for removing whole muscle bundles versus small scraps” (1986c: 143). The MRM data provide a sample of Blumenschine’s first requirement, while his second request calls for additional actualistic research.

Blumenschine’s point about distinguishing between the removal of small scraps of meat and large amounts of meat is a good one and is not answered directly here. Nevertheless, indirect evidence is worthy of mention in this regard. The fact that meat-bearing bones such
as femur and humerus shafts do retain cut marks indicates that at least some meat was removed. Because bones of lower utility such as the tibia and radio-ulna (Blumenschine & Caro 1986) retain proportions of cut marks not notably different from that seen in the MRM assemblage, is strong circumstantial evidence that hominids acquired access before carcasses were entirely cleaned and ravaged by non-hominid scavengers (see Oliver 1994; Selvaggio 1998). It appears that hominids were not only removing small scraps of meat (contra Blumenschine 1986b, 1986c; see Oliver 1994; Selvaggio 1998). Based on this observation I propose as elsewhere that, - in the sequence of meat eaters - hominids can be placed quite accurately between successful non-hominid hunters as well as aggressive and successful non-hominid scavengers and the most marginal non-hominid scavengers. Apparently hominids were employing a strategy of active scavenging, but lacked the capacity to gain or retain control of carcasses over aggressive non-hominid hunters and/or active scavengers such as lion and hyaena. As proposed below, having gained access to some meaty parts indicates that hominids were not restricted to marginal scavenging and may be placed ahead of the most marginal of scavengers like jackals and vultures.

6.4.3.1. Comparisons of cut mark data from MRM and FLK.

The following is a presentation and interpretation of results from correlation analyses and visual examination of bar graphs respectively. Below I compare the proportional distribution of cut mark frequencies and cut marked pieces from MRM and FLK. The sample of small animal specimens from FLK is rather small, consisting of 140 specimens of appendicular elements included in the current analysis of which 33 are cut marked (23%). A larger sample from a hominid site with cut marks quantified according to current standards is required to test or verify interpretations offered here. For that reason, interpretations offered below are provisional, but some striking differences between the MRM and FLK assemblages can not be ignored and call for serious consideration. In addition, I propose that interpretations offered here are based on a well-controlled actualistic assemblage of butchered bones and interpretations are therefore favourably supported.

For the following analyses, cut marks on bones from the MRM study resulting from all butchery activities are included since the use of the filleted exclusively sample will result in significant under representation of cut marks at epiphyses. Additionally, the filleted and disarticulated sample is too small to use alone.
With the purpose of making the assemblages comparable, cut mark data from MRM and FLK were standardised as explained above in section 6.4.2. Due to the nature of the data, only proportional distributions of mean cut mark frequencies and cut marked pieces across different anatomical loci and within skeletal elements could be compared. For the MRM data, proportional cut mark frequencies were calculated by dividing the mean cut mark frequency per MNE for a given anatomical portion by the sum of the mean cut mark frequencies per MNE for all anatomical portions included in the analysis. The calculated value was then multiplied by a hundred to represent a proportion (percentage) of the total mean cut mark frequencies of portions included in the analysis (see Table 6.2). Similarly, for the FLK data, proportional frequencies of cut marked specimens were calculated by dividing the number of cut marked pieces per NISP for a given anatomical portion by the total number of cut marked pieces per NISP. The result was then multiplied by a hundred to represent a proportion (percentage) of the total number of cut marked pieces on anatomical portions included in the analysis. In other words, for both assemblages each anatomical portion was represented by an index of the mean cut mark frequency and number of cut marked pieces of the total mean cut mark frequency and total number of cut marked pieces (% MCF of total MCF and % CP of total CP; for example, Figure 6.19).

Regarding the MRM assemblage, a comparison of the proportional distribution of cut marks across different anatomical loci on small bovid bones with those on large bovid bones shows that the two size groups retain similar proportions of cut marks (Figure 6.17). This is interesting considering that MCFs for large bovids are significantly higher than for small bovids. This implies that, when different butchery strategies are performed on differently sized animals (possibly as a result of differential access to or treatment of different size animals), the proportional distribution of cut mark frequencies can be expected to differ markedly between small and large bovids. The latter issue is not investigated here since access to animal carcasses was not a concern for the MRM butchers. Figure 6.17 shows that the highest proportions of cut marks in the MRM assemblage are concentrated on the upper front and rear limbs including scapulae, humeri, pelves, and femora, but particularly high proportions occur on scapulae and pelves. This demonstrates that limb bones with large quantities of meat retain higher proportions of cut marks than limb bones with smaller quantities of meat. This is particularly apparent from the high proportions of cut marks occurring on scapulae and pelves of both small and large bovids. Since a relatively small number of animals in the MRM study were filleted and disarticulated, cut marks at proximal
and distal ends are undoubtedly under represented. Consequently, additional actualistic butchery studies are required to resolve this aspect. Nevertheless, the overall patterning is not seriously affected by this shortcoming.

Figure 6.17. Proportional distribution of mean cut mark frequencies (MCFs) per MNE of the total MCF per MNE across different anatomical loci on small and large bovid bones including all cut marks on appendicular elements in the MRM assemblage.

A correlation analysis shows that cut marked pieces across different portions on small and large bovid bones from FLK are not significantly correlated ($r_s = 0.33$, $P > 0.05$). Figure 6.18 shows that for both size groups, the highest proportions of cut marks are recorded at the distal humerus and distal tibia. While the distal humerus is at the distal extreme of the meatiest part of the front limb, the distal tibia has very little meat associated with it (Blumenschine & Caro 1986; personal observations). This is in stark contrast to the pattern observed for the MRM assemblage. Although a high proportion of cut marks occur on pelves of large bovids, and surprisingly, are entirely absent from small bovids at FLK, Bunn and Kroll (1986) do not provide detailed locations of these marks and therefore the possibility of cuts clustering around the acetabulum can not be ruled out. The latter, particularly if cuts are common within the acetabular ‘bowl’, would indicate disarticulation as opposed to filleting. This supports the notion that documentation and publication of precise cut mark location and orientation is critical to realistic interpretations.

Cut mark proportions are roughly the same for both size groups at the humerus shaft and distal shaft, proximal radius and shaft, distal ulna, and distal tibia. The size groups differ most
notably in the following ways: cut marks are entirely absent from small bovid scapulae but present on those of large bovids, albeit among the lowest proportions recorded for large bovids; while the fifth highest proportion of cut marked anatomical portions on small bovid bones, cut marks are absent from large bovid proximal humeri; while entirely absent on small bovids, cut marks are present on the distal radius, proximal end and shaft of the ulna, and proximal end of the femur on large bovid bones; conversely, while absent on large bovid bones, the proportion of cut marks on the distal femur is of the highest on the bones of small bovids; albeit among the lowest proportions, cut marks are present on the proximal tibia of small bovids but entirely absent on those of large bovids. For very few elements (less than 25%) are the proportions of cut marked pieces roughly the same for both size groups. The above-mentioned discrepancies as well as the lack of correlation demonstrate notable differences in the proportions of cut marked specimens across different anatomical portions between small and large bovids at FLK. This pattern is markedly different from that observed for the proportional distribution of cut marks on small and large bovid bones in the MRM assemblage.

As mentioned above, a pattern of significant disparity in the proportions of cut marks across different anatomical portions between animal size groups can be expected if animals were processed differently as a result of discrepancies in access to and/or treatment of differently sized animals. This suggests that hominids at FLK employed different butchery procedures and/or carcass acquisition strategies when extracting soft tissues from the bones of small and large animals. It is interesting to note that limb bones associated with large quantities of meat (scapulae and pelves) do not retain the highest proportions of cut marks for either small or large bovids in the FLK assemblage (contra Bunn & Kroll 1986: 436). This pattern varies from that observed for the MRM assemblage. Skeletal elements with lesser quantities of meat (distal humerus and distal tibia) retain of the highest proportions of cut marks on both small and large bovid bones from FLK (contra Bunn & Kroll 1986: 436). This strongly suggests that, although the two animal size groups were - for whatever reasons - butchered differently, hominids depositing cut marked bones at FLK Zinjanthropus did not have full access to either large or small animals. This proposition is substantiated below in comparing the proportional distribution of cut marks on bones from the MRM assemblage with those from FLK, and in section 6.5 where the FLK and KRM1 assemblages are compared.
Figure 6.18. Proportional frequency distribution of cut marked specimens per NISP across different anatomical loci on small and large bovid appendicular bones from FLK Zinjanthropus (Bunn & Kroll 1986).

6.4.3.2. A comparison of cut mark data on small bovid bones from MRM and FLK

Having discussed similarities and differences in the proportional distribution of cut marked bones between small and large bovids from FLK, and how these compare with the MRM data, I now turn to comparing the proportional distribution of cut mark frequencies and cut marked specimens on bones of small bovids from the MRM and FLK assemblages.

Figure 6.19 shows that the proportional distribution of MCFs and cut marked pieces across different anatomical portions for MRM and FLK are markedly different for nearly all skeletal portions. Correlation analysis supports this visual observation, and there is not a significant correlation between the two assemblages ($r_s = -0.13$, $P > 0.05$). In considering only the meaty bones, the proportional distribution of cut marks and cut pieces is particularly different on scapulae and pelves from the two assemblages (Figure 6.19). This result indicates that small animals at FLK were butchered differently from those in the MRM assemblage. The reasons for this difference may range from butchery and carcass acquisition strategies to butchery tools and cultural differences, but I argue below that factors affecting cut mark frequencies may be more narrowly defined. Figure 6.19 and the lack of correlation between the two assemblages suggest that hominids depositing cut marked bones at FLK did not have full access to the carcasses of small animals. I base this proposition on the
assumption that full access to carcasses would result in proportional cut mark frequencies similar to those observed for the MRM assemblage.

The skeletal portions at which proportional distributions of cut marks differ between the assemblages should indicate discrepancies in either butchery, carcass acquisition strategies, butchery tools, or cultural differences, to mention a few, or some combination of these variables. If certain anatomical portions were similarly cut marked at MRM and FLK, then variation in butchery tools or cultural practices were unlikely the major agents affecting proportional distributions of cut marks. Rather, similarity between MRM and FLK in proportional distributions of cut marks on some anatomical portions, would indicate that butchery and carcass acquisition strategies are likely the dominant agents in producing differences in the proportional distribution of cut marks.

At the outset I was not confident that any anatomical portions from MRM and FLK would display similar proportions of cut marks or cut marked pieces because the two assemblages were formed under extraordinarily divergent circumstances. For example: the MRM assemblage was generated in 1993 while cut marked bones at FLK were deposited between 1.86 and 1.76 million years ago (Walker et al. 1991); the MRM butchers made most of their cuts with metal knives while FLK hominids used stone and/or bone artefacts; at MRM, access to animals was not an issue while hominid access to animal carcasses in all likelihood varied considerably; MRM butchers had uninterrupted access to carcasses and butchered them thoroughly; in contrast, FLK hominids are likely to have faced a suite of adversaries and quite likely had interrupted access to carcasses, probably resulting in unequal and haphazard butchery; transport of carcasses or elements was not an issue at MRM while almost certainly a consideration at FLK. Nevertheless, given all these differences, the one trait the MRM and FLK butchers had in common was removing tissues from bones (e.g., Binford 1981; Bunn 1981, 1983b; Bunn & Ezzo 1993; Bunn & Kroll 1986; Oliver 1994; Potts 1983; Potts & Shipman 1981). Disarticulation is largely avoided here since the sample created at MRM is too small for comparison. Moreover, I established that it is only at epiphyses where disarticulation affects cut mark frequencies. Consequently, inflated proportional frequencies of cut marks at epiphyses are more than likely the result of disarticulation. Below I aim to demonstrate that it is the removal of tissues from bones that has significant influence on the proportional distribution of cut marks across different anatomical portions and elements, and that variation in the proportional distribution of cut marks...
marks stems from the presence or absence of tissues when carcasses are acquired and butchered.

Figure 6.19 shows that for certain anatomical portions, such as the humerus, femur shaft, distal femur, and to a lesser extent the proximal tibia and tibia shaft, there is remarkable agreement in the proportional distribution of cut marks and cut marked pieces from MRM and FLK. These results indicate that, regardless of variation in butchery tools, butchery and carcass acquisition strategies, culture or additional variables mentioned previously, the butchers at MRM and FLK were generating similar proportions of cut marks at the above-mentioned elements and anatomical portions. According to the observations made at MRM, we expect that if hominids did have full access to carcasses, then they would generate cut marks with roughly the same proportions as those observed in the MRM assemblage where butchers had full access to carcasses. I suggest that the variation evident in the proportional frequencies of cut marks at anatomical portions not included in the above lists, reflects differences in access to animal carcasses. Meat could not have been present in large quantities on, for example, scapulae and pelves. Since pelves are high in the carnivore consumption sequence (Blumenschine 1986a), it appears that hominids had access to this element only after carnivore consumption. The observed paucity of cut marks on ulnae in both assemblages is likely due to the relatively small surface area of this element and that ulnae are associated with relatively small amounts of meat (e.g., Binford 1981; Blumenschine & Caro 1986).

The complete absence and scarcity of cut marks on scapulae and pelves respectively, strongly suggest that hominids at FLK did not have full access to carcasses of small bovids. As alluded to above, it appears that hominids at FLK were, at best, second in line to other carnivores regarding access to animal tissues. This notion is further supported by the exceptionally high incidence of cut marks on the distal tibia, a portion of the skeleton not associated with large quantities of meat (Blumenschine & Caro 1986), and that also ranks low in the carnivore consumption sequence (Blumenschine 1986a). Furthermore, cuts at distal tibiae may be associated with disarticulation.
Figure 6.19. Proportional frequency distribution of MCFs and CPs across different anatomical portions on small bovid bones from FLK *Zinjanthropus* (Bunn & Kroll 1986) and the complete Merriman sample. MCF = mean cut mark frequency (MRM) and CP = cut marked pieces (FLK).

Figure 6.20 shows the proportional distribution of cut marks across different anatomical portions by skeletal element on small animal bones from FLK and MRM. Indices for anatomical portions were calculated by dividing the mean cut mark frequency per MNE (MRM) or number of cut marked pieces per NISP (FLK) for a given portion by the total mean cut mark frequency per MNE (MRM) or summed number of cut marked pieces per NISP (FLK) for the appropriate skeletal element. The result was multiplied by a hundred to represent a proportion (percentage) for a given anatomical portion (% MCF per element or % CP per element). A correlation analysis shows that there is not a significant correlation in the proportional distribution of cut marks across different anatomical portions by skeletal element on small animal bones from FLK and MRM ($r_s = -0.25$, $P > 0.05$). This indicates that hominids at FLK did not have full access to carcasses of small animals and/or processed them differently from butchers at MRM.

Bunn and Kroll (1986) did not provide separate counts of cut marked specimens for scapula shafts and epiphyses. Nevertheless, not a single piece of scapula bone was cut marked at FLK while 100% of butchered scapulae were cut marked at MRM. The effects of fragmentation on cut mark frequencies has been alluded to above, and clearly the proportion of cut mark frequencies on scapulae in the MRM assemblage will be reduced by fragmentation. Clearly this matter requires additional actualistic research. The fact that no
scapula fragments were cut marked at FLK suggests that soft tissues were not present on scapulae when hominids acquired and butchered animals at that site. Bear in mind that scapulae retain the highest frequencies of cut marks of all skeletal elements in the MRM assemblage. This is essentially due to the fact that large quantities of meat are associated with scapulae and because these bones are difficult to fillet – due to their morphological structure - without creating cut marks on bone surfaces. As argued above, this strongly suggests that hominids did not acquire this element while fully fleshed and consequently, hominids did not have full access to carcasses of small animals (*contra* Bunn & Kroll 1986).

The proportional distribution of cut marks across different portions of the humerus is remarkably similar for both assemblages (Figure 6.20). Nevertheless, the proportions at the proximal end and distal end on FLK small bovid humeri are slightly higher than on those portions in the MRM assemblage. As mentioned above, this is more than likely due to the small sample of filleted and disarticulated carcasses in the MRM assemblage and the subsequent under representation of cut marks at epiphyses. The proportion of cut marks on the humerus shaft is almost identical for both assemblages. I interpret this as hominids having full access to humeri of small bovids. In turn, this indicates that hominids acquired small animal carcasses before the bones were entirely cleaned by non-hominid scavengers such as jackals and vultures. Clearly, hominids were not last in the queue for animal tissues, but were practicing some form of active scavenging. Since non-hominid carnivores like lion and hyaena rapidly consume entire carcasses of small bovids (Blumenschine 1986a, 1986c, 1987; Kruuk 1972; Schaller 1972), it is possible that hominids were scavenging complete or partially consumed small bovid carcasses from tree-stored leopard kills (Cavallo & Blumenschine 1989).

On radii we see an inverted situation in the proportions of cut bones and cut mark frequencies from FLK and MRM. Proportions of cut pieces decrease from proximal to distal ends at FLK and proportions of cut mark frequencies increase from proximal end to distal ends at MRM. On FLK radii, proportions of cut marks drop from almost 70% on the proximal end, to just over 30% on the shaft. The distal end of radii is not represented at FLK. On MRM radii, proportions rise from approximately 10% on the proximal end, to almost 20% on the shaft, and to about 70% on the distal shaft. This pattern can be rationalized. Firstly, only one animal was disarticulated in the MRM sample and therefore cut marks at the proximal epiphysis are significantly under represented. Second, most cutting actions employed while filleting radii were performed with the cutting edge held at a very shallow
angle with the bone surface, shaving meat from the bone, and consequently leaving very few microscopically visible traces. The high incidence of cut marks at the distal end is a combination of lumping the distal shaft with the distal epiphysis to make my data comparable with Bunn and Kroll’s, and because skinning the front limbs at MRM was often initiated with circular cuts around distal shafts of radio-ulnae. The high proportion of cut marks at proximal ends of FLK radii may be a result of both filleting and disarticulation since the MRM data has revealed that many filleting cut marks are created at proximal epiphyses of radii. Additionally, the MRM data has shown that cut mark frequencies are increased at epiphyses when bones are disarticulated. Overall, cut mark data on FLK radii indicate that hominids had more or less full access to this element while still fleshed. The mode of hominid carcass acquisition mentioned above applies here too.

Cut marks are entirely absent from small bovid ulnae at FLK. This is intriguing considering that some meat is associated with the proximal shaft and end, particularly around the olecranon. This is partly explained by the very small sample (10 specimens) representing this element at FLK. The absence of distal ulna pieces makes it impossible to assess butchery of this element at FLK. The high proportion of cut marks on the proximal end of the MRM ulnae reflect filleting muscles originating on the humerus and inserting on and encasing the olecranon. Only one animal was disarticulated and therefore cut mark frequencies can be expected to increase at this location when animals are systematically disarticulated. Additional actualistic research is required to resolve this issue.

A very small proportion (14.3%) of pelvis specimens from FLK was cut marked. As with scapulae, Bunn and Kroll (1986, Table 4) do not provide cut mark data for different portions of pelves. It is not possible, therefore, to establish whether cut marks clustered on the non-acetabular portion and/or on and around the acetabulum. Cut mark placement would indicate whether hominids were filleting and disarticulating or exclusively disarticulating. The appropriate data are required for detailed interpretation. Even though the proportion of cut marks on pelves at MRM is inflated due to the absence of fragmentation, pelves retain of the highest cut mark frequencies of all skeletal elements. In the FLK assemblage, the pelvis retains the lowest proportion of cut marks of appendicular skeletal elements. This strongly suggests that hominids did not have full access to this element (one of the meatiest limb bones) (e.g., Blumenschine & Caro 1986). As seen with scapulae, this suggests that hominids had secondary access to pelves.
The proximal femur is represented by a single specimen at FLK. As a result I offer no interpretation of this portion. The proportion of cut marked pieces and cut mark frequencies on femur shafts at FLK and MRM are almost identical. This implies that hominids acquired this element while more or less fully fleshed. Similarly, proportions are not markedly different at the distal ends. Bear in mind that cut mark frequencies are deflated on the MRM distal femora due to the small sample of disarticulated elements. We can expect, therefore, that proportions of cut pieces and cut mark frequencies on distal femora at FLK and MRM will be more alike if the amount of disarticulation was increased in the actualistic sample. The fact that proportions of cut pieces and cut marks at FLK and MRM are almost identical on shafts of femora, indicates that hominids were not exclusively disarticulating femora from tibiae, but were removing tissues as intensively as butchers at MRM. Overall, hominids seem to have had full access to at least femur shafts and distal ends while still fleshed. Inflated proportions of cut marked pieces at the distal end suggest that bones were disarticulated. The interpretation offered here is in line with interpretations offered above for humeri and radio ulnae. Hominids appear to have actively gained access to at least some meaty limb bones of small animals before they were entirely defleshed and/or consumed by non-hominid carnivores and scavengers. Perhaps hominids were scavenging from partially consumed, tree-stored leopard kills (Cavallo & Blumenschine 1989).

Proportions of cut marked pieces and cut mark frequencies on different portions of tibiae from FLK and MRM are roughly the same except on distal ends. The relatively inflated cut mark frequencies on the proximal end and shaft in the MRM assemblage is the result of significant under representation of cuts on distal ends because metatarsals were disarticulated by cutting against and between tarsal bones. At FLK, disarticulation of metatarsals appears to have impacted the distal tibia, a situation also observed at KRM1. This may be due to differences in faculties and flexibility between metal and stone tools. In part, the inflated proportion of cut marked pieces on the distal ends at FLK reflects the nature of the ankle joint. For example, unlike the articulation between the proximal tibia and distal femur, which is loose and open, the ankle joint is tight and ‘closed’. For that reason, disarticulating tibiae from metatarsals is expected to produce more cut marks than disarticulating femora from tibiae. This issue is discussed in more detail above where the MRM and KRM1 assemblages are compared. Given the above-mentioned factors, proportions of cut marked pieces on FLK tibiae, particularly the presence of cuts on proximal ends and shafts, indicate more or less full
access to this element on the part of hominids. Similar acquisition strategies as described above apply to tibiae.

Although not represented in the figures, cut marks on ribs of small animals are almost entirely absent (0.5%) in the FLK assemblage (Bunn & Kroll 1986, Table 4). I briefly discuss a few implications of this observation because, in contrast, small bovid ribs retain a significant number of cut marks in the MRM assemblage. The rarity of cuts on FLK ribs may be explained in several ways and not all possibilities are entertained here. Hominids may not have had access to tissues on or inside the rib cage due to carnivore consumption of tissues and viscera (Blumenschine 1986a, 1986c). Hominids may have had access to this part, but ate meat directly from bones, therefore not leaving cut marks. The absence of cuts at the proximal ends of ribs, however, suggests that these parts were never disarticulated from the vertebral column (see Table 4, Bunn and Kroll 1986). If ribs were not disarticulated, then it is hard to imagine hominids applying their teeth to intercostal meat and tissues adhering to the lateral surfaces of rib shafts. Keep in mind that sirloins are associated with the proximal portion of lateral rib shafts, and also that sirloins along with meat on the rump are relatively high on the carnivore consumption sequence (Blumenschine 1986a). It appears more likely, therefore, that hominids acquired rib cages in at least partially defleshed form. Alternatively, hominids may have avoided tissues on ribs due to the sinuous nature of meat encasing ribs, particularly tissues distal of sirloins. One may expect however, given their secondary access to animal tissues, that hominids would have utilized all edible tissues available to them. Since transport is not a major issue with small animals, it remains intriguing why ribs were neither disarticulated nor defleshed. A single cut piece out of 210 specimens can not be interpreted as thorough filleting.
6.4.3.3. A comparison of cut marks on large bovid bones from MRM and FLK

First, the proportional distribution of cut marked pieces (FLK) and frequencies of cut marks (MRM) across different anatomical locations are compared between the two assemblages. Data from the two assemblages were standardised, as described above in section 6.2, to make them comparable. Indices were calculated in the same manner as described above for small bovids. Second, the proportional distribution of cut marked pieces (FLK) and cut mark frequencies (MRM) within individual skeletal elements is compared between the assemblages. Indices were calculated as were those described above for small bovids. The sample of large animal specimens from FLK is considerably better than that of small animals; consisting of 356 specimens of appendicular skeletal elements included in the current study, of which 56 (15.7%) are cut marked. Consequently, interpretations of cut mark data for large animals from FLK are more robust than those offered for small bovids. Variation in the proportions of cut marked pieces of small and large bovid bones from FLK are discussed above.

A correlation analysis reveals that there is not a significant correlation in the proportional distribution of cut marked pieces and frequencies of cut marks across different anatomical locations on the bones of large animals from FLK and MRM ($r_s = 0.09$, $P > 0.05$). With the exception of the proximal femur, the overall proportional distribution of cut marks and cut
marked pieces is markedly different at MRM and FLK (Figure 6.21). This implies that, overall, large animal carcasses comprising the two assemblages were butchered differently. See the more detailed discussion above in the small bovid section regarding variables affecting proportional distributions of cut marks and butchery procedures. Concerning the meaty limb bones, the most marked difference between the two assemblages is at the scapula, proximal humerus and pelvis (Figure 6.21). This indicates that the upper limb bones, just listed, were butchered differently at FLK and MRM. I have argued above that the differential distribution of proportions of cut marked pieces and cut mark frequencies are a result of differences in access to meat. This argument is supported by the large bovid data, except for the high incidence of cut marks on distal tibiae at FLK, in that the limb bones distal of the femur and humerus retain roughly similar proportions of cut marks and cut marked pieces at both MRM and FLK. This indicates that when soft tissues were available, butchers at MRM and FLK inflicted similar proportions of cut marks on bones.

The fact that the proportional distribution of cut marks differ on the upper limb bones proximal of the radio-ulna and tibia, indicates that hominids did not acquire the upper limb bones before a significant amount of tissue was consumed by other non-hominid carnivores. Pelves and femora are highest on the carnivore flesh consumption sequence (Blumenschine 1986a), and the differential distribution of proportional frequencies of cut marked specimens on pelves at FLK compared with MRM, is compelling evidence that hominids did not have early access to pelves. It is more likely that hominids acquired these elements after non-hominid carnivores consumed significant quantities of tissues. Furthermore, Bunn and Kroll (1986) do not present accurate data regarding the exact locations of cut marks on pelves. For more realistic interpretations, we need to know whether cuts were concentrated on the non-acetabular portions or around and on the acetabulum.

Moreover, when pelves are excluded from consideration for reasons mentioned above, we note that the highest proportions of cut marked specimens are the distal humerus and distal tibia (Figure 6.21). Inflated cut mark frequencies at these locations suggest increased effort in disarticulation. Keep in mind that the distal humerus is at the lower extreme of the meatiest part of the front limb, and because this portion retains the highest number of cut marked specimens suggests that hominids were focusing on disarticulating this element from the radio-ulna. Accurate presentation of cut mark locations is required for verification of disarticulation. Distal tibiae are associated with small quantities of tissue (Blumenschine & Caro 1986) and exaggerated cut mark proportions suggest disarticulation of this part from the
metatarsal. Disarticulation of skeletal elements was almost certainly taking place at FLK (contra Shipman 1983).

Cut marked humeri and femora shafts indicate that some tissues were still adhering to these bones when hominids acquired them, but the overall pattern indicates that hominids did not have full or early access to the carcasses of many large animals as argued by Bunn and Kroll (1986: 439). The paucity of cut marked pieces of proximal humeri and femora suggest that tissues were largely absent from these portions when hominids acquired large animal carcasses. Proximal humeri and femora however, are represented by very few specimens (4 and 6 respectively) and therefore this suggestion is tentative. Having said that, cut marked shaft specimens suggest that hominids were not extracting marrow exclusively, but were cutting some meat off large animal carcasses. As proposed by Blumenschine (1986b), hominids may have removed scraps of meat from some bones remaining from carnivore feeding episodes, but as demonstrated above, hominids apparently removed meat from bones ranking low in the carnivore flesh consumption sequence (Blumenschine 1986a). Hominids were therefore not the most marginal of scavengers as suggested by Binford (1981, 1983, 1984c, 1988).

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Figure 6.21. Proportional distribution of mean cut mark frequencies per MNE (MCF) and cut marked pieces per NISP (CP) of large bovid bones from the complete MRM sample and the FLK *Zinjanthropus* assemblage (Bunn & Kroll 1986).
The proportional distribution of cut marked pieces and mean cut mark frequencies on portions of individual skeletal elements is briefly examined. A correlation analysis demonstrates that there is not a significant correlation between FLK and MRM ($r_s = 0.03, P > 0.05$). Again, this suggests different butchery procedures reflected by the two assemblages. A few observations are pointed out with reference to Figure 6.22. Because Bunn and Kroll (1986: Table 4) do not provide counts of individual cut marks, the assumption is made that the intensity of butchery is reflected more or less the same by the number of cut marked pieces (FLK) and the number of cut marks (MRM) on a given anatomical portion. Bones from the MRM assemblage are not fragmented, and the effect of fragmentation on cut mark frequency is likely to result in reduced cut mark frequencies. This aspect requires additional actualistic research.

Scapulae retain the highest frequencies of cut marks of all appendicular elements in the MRM assemblage. As mentioned above, this is due to the morphological structure of this element and because scapulae retain the largest quantities of meat on front limbs (Blumenschine & Caro 1986). Unlike many other limb bones (except pelves) scapulae consist of flat and angular bone surfaces. Butchers, therefore, are prone to make contact with bone regularly while defleshing this element. Because scapulae are associated with significant quantities of meat, much effort is expended during filleting. This observation is more apparent for large than small bovids, yet small bovid scapulae are also cut marked more frequently than any other appendicular elements. Figure 6.22 shows that a very small proportion of scapula specimens are cut marked at FLK, substantiating the interpretation offered above that hominids acquired this element after significant quantities of meat were consumed by non-hominid carnivores.

Given that proximal humeri are poorly represented at FLK, the proportions of cut marks on shafts and distal ends is not greatly different from that observed at MRM. This suggests that at least the lower part of the meatiest portion of the front limb was available to hominids before this element was entirely cleaned of flesh. Apparently hominids were able to acquire this element before all nutrients were extracted by non-hominid scavengers, placing hominids before the most marginal of scavengers (contra Binford 1981, 1983, 1984c, 1988).

Interestingly, the proportions of cut marks on different portions of radio-ulnae at FLK are almost identical to those at MRM (Figure 6.22). This is compelling evidence that hominids had full access to these elements. Radio-ulnae rank lowest in the carnivore flesh consumption sequence (Blumenschine 1986a), and along with data for the high ranking elements, full
access to this element suggests that hominids were, more often than not, acquiring large animal carcasses after initial consumption by non-hominid predators, but before marginal non-hominid scavengers. A form of active scavenging on the part of hominids is envisaged.

Because we do not know exactly where cut marks are located on pelves at FLK, it is not possible to offer a convincing interpretation. Knowing the precise placement of marks is critical to evaluate the presence or absence of filleting or disarticulation.

Due to the small sample of proximal and distal femora as well as proximal tibiae fragments in the FLK assemblage, I am unable to make a detailed comparison between the assemblages. If proximal and distal femora fragments were more numerous then a more realistic interpretation of the proportions of cut marks on different portions could be offered. Nevertheless, the similarity in the proportions of cut marks on the tibia shaft in both assemblages suggests that hominids had access to this element before non-hominid carnivores consumed significant quantities of meat from tibiae. Keep in mind that tibiae rank second lowest in the carnivore flesh consumption sequence (Blumenschine 1986a). The relatively high proportion of cut marks on the tibia shaft also indicates that hominids gained access to this element before it was entirely cleaned by marginal non-hominid scavengers. This observation supports the interpretation offered above for other skeletal elements. The high proportion of cut marks on the distal tibia indicates intensive disarticulation of tibiae from metatarsals. This observation, along with high proportions of cut marks at the ends of other limb bones, is in conflict with Shipman’s (1983) suggestion that hominids were rarely disarticulating carcasses.
Figure 6.22. Proportional distribution of cut marked pieces per NISP (FLK) and mean cut mark frequencies per MNE (MRM) on different anatomical portions by skeletal element on large bovid bones. Data for FLK was derived from Table 4 in Bunn and Kroll (1986: 437).

Based on data presented here, it appears that hominids acquired large animal carcasses after initial consumption by non-hominid predators, but before bones were entirely cleaned and ravaged by non-hominid carnivores practicing an approximately full-time form of scavenging. The MRM data provides compelling evidence that hominids were not acquiring fully fleshed large animal carcasses, but gained access to certain elements before they were fully defleshed and ravaged by marginal scavengers. In the chain of meat eaters, hominids can be placed, with reasonable confidence, somewhere between successful hunters such as lion, hyaenas, leopard, and cheetah, and opportunistic and marginal scavengers including jackals and vultures. When compared with cut mark data from FLK, the MRM data strongly indicate that hominids were not the most marginal of scavengers (contra Binford 1981, 1983, 1984c). If hominids were involved in hunting and did kill large animals, the data suggest that they were not able to retain full and uninterrupted possession of such carcasses. Hominids were apparently kept at bay while more dominant predators and carnivores consumed the meatiest parts of carcasses. It seems more likely that between 1.86 and 1.76 million years ago (Walker et al. 1991) hominids were unsuccessful hunters but had developed a ‘social structure’ enabling them to acquire considerable amounts of marrow and at least some meaty parts of large animal carcasses. By ‘social structure’ I simply mean some form of group
activity. That hominids were acquiring meat from at least some skeletal elements suggests some form of group activity since solitary hominids were unlikely to have scavenged successfully in competition with socially organized and aggressive scavengers such as hyaenas and wild dogs (see Oliver 1994 and references for discussion on socioecological implications). In sum, concerning the consumption of animal products, active and successful scavenging appears to have been the strategy employed by hominids depositing cut marked bones at FLK Zinjanthropus. This interpretation is not entirely at odds with that offered by Bunn and Kroll (1986: 442). There are, however, significant differences in the details of my and Bunn and Kroll’s interpretations and I suggest that the interpretation offered here is based on a considerably more robust frame of reference and methodology than that used by Bunn & Kroll some fifteen years ago.

The interpretations offered above are not entirely new (e.g., Blumenschine 1985; Cavallo & Blumenschine 1989; Marean 1989; Oliver 1994; Selvaggio 1994, 1998), but they are based on an unprecedented actualistic assemblage for which butchery procedures were controlled and separated to avoid the palimpsest predicament of overprinted butchery activities, and for which butchery was filmed to facilitate reviewing butchery activities and their impact on carcass portions several times after the fact. Moreover, interpretations offered above are guided by a novel methodology for assessing carcass acquisition strategies, in which proportional distributions of cut mark frequencies at different anatomical portions produced on bones in the MRM assemblage are compared with archaeological assemblages. Certain anatomical portions from the MRM and FLK assemblages retain proportional distributions of cut mark frequencies that are not markedly different. This lends considerable support for the value of employing proportional distributions of cut mark frequencies to assess carcass acquisition strategies practiced by hominids.

My placement of hominid’s access to carcasses between successful non-hominid hunter/scavengers and the most marginal of scavengers is supported by Selvaggio’s (1998) carnivore-hominid-carnivore experimental model. The value of Selvaggio’s model for determining early or late access to animal carcasses requires assessment. This may be achieved by comparing it with ethnoarchaeological and Later Stone Age assemblages where access to carcasses is not a major concern. Among others, Oliver (1994) has argued convincingly that hominids were the dominant accumulators of bones at FLK. The nature of the FLK data, however, does not represent carnivore activity before the cut marked bones were transported and deposited at FLK. The cut mark data presented here indicates that
hominids acquired carcass parts after initial feeding by non-hominid carnivores. Both Oliver (1994) and Selvaggio (1998) demonstrated that carnivores damaged bones after hominids processed certain parts for marrow and flesh. At present it appears that hominids had intermediate access to animal carcasses. The socioecological implications of hominids acquiring carcass parts and probably transporting them to a safe area for processing and consumption is discussed in detail by Oliver (1994 and references therein).

The cut mark data from FLK is discussed further below in section 6.5 where it is briefly compared with cut mark data from the Middle Stone Age layers of Klasies River Mouth (Milo 1994, 1998).

6.5. HOMINID STRATEGIES OF CARCASS ACQUISITION AND BUTCHERY IN THE UPPER PLEISTOCENE (KRM1) AND PLIO-PLEISTOCENE (FLK ZINJANTHROPOS)

6.5.1. Introduction

Here I offer a very brief discussion of a comparison between the cut mark data from KRM1 and FLK. A more detailed comparison awaits more detailed information on the anatomical placement and orientation of cut marks for both sites, and when similar methodologies for recording cut marks and calculating MNEs and MCFs are applied to both assemblages. The purpose of this comparison is to determine whether the methodology employed below and in sections 6.3 and 6.4 is sensitive to differences in butchery as practiced by hominids in the Upper Pleistocene and Plio-Pleistocene., separated by about 1.7 million years. In all likelihood, real differences do exist, but are they detectable with the methodology employed here? While the inhabitants of KRM1 were anatomically near-modern, hominids at FLK were certainly not. Consequently, we may reasonably expect that strategies of butchery and carcass acquisition were not the same at KRM1 and FLK. Binford has argued, however, that inhabitants of both sites were marginal scavengers of large animal carcasses (Binford 1981, 1985), thus implying that hominids in the Upper Pleistocene were acquiring and butchering large carcasses in the same way as hominids some 1.7 million years earlier. This scenario is challenged below. Although dominated by unretouched flakes, the stone tool technology of the MSA at KRM1 is considerably more sophisticated than that at FLK. While stone artefacts at KRM1 include stone points (levallois points) produced from prepared cores, the stone technology at FLK is largely restricted to cores and flakes. The
production of intentionally designed stone points, and the presence of the tip of a broken stone point lodged in the neck of a *Pelorovis* at KRM1, is compelling evidence for the use of weapons for killing large animals. Such evidence is not present at FLK. Large blades with long cutting edges are common in the MSA, while such refined butchery tools are absent from the Early Stone Age (ESA).

Below I attempt to answer the question; did MSA hominids at KRM1 acquire and butcher animals in the same manner as their Early Stone Age hominid predecessors at FLK *Zinjanthropus*?; or had hominid carcass acquisition skills evolved by the time KRM1 was occupied?

With the purpose of making the two assemblages comparable, the data from KRM1 and FLK were standardised following the same procedures as used to modify the MRM cut mark data (see section 6.4.2) for comparison with that from FLK in section 6.4.3.

I compare the proportional distribution of MCFs and cut marked pieces (CP) across different anatomical portions of the skeleton on small (section 6.5.2) and large bovid bones (section 6.5.3) from the two assemblages. As in section 6.4, the assumption is made that the number of cut marked pieces at FLK is more or less equal to the number of cut marks per element and portion at KRM1. Spearman’s coefficient of rank correlation was used for comparing the assemblages (Blalock 1972).

### 6.5.2. Comparing cut mark data for small animals from KRM1 and FLK

A correlation analysis shows that the proportional distribution of MCFs (KRM1) and CPs (FLK) across different anatomical portions of the skeleton on small bovid bones from KRM1 and FLK are not significantly correlated \( r_s = 0.07, P > 0.05 \). This result indicates that hominids at FLK did not process animals and/or did not have the same access to carcasses of small bovids as the butchers at KRM1. Having showed that cut mark frequencies and cut marked pieces do not correlate, I examined the bar graph (Figure 6.23) to explain which anatomical portions may or may not account for the lack of correlation between the two assemblages. Interpretations of butchery and carcass acquisition strategies can be formulated with respect to elements and portions displaying similarities as well as displaying differences in the cut mark data for KRM1 and FLK. Due to their under representation in Milo’s (1994, 1998) sample, mid shaft portions are largely excluded from comparisons between the assemblages.
The complicating factor in calculating MNE and MCF for pelves described in section 6.3.2 is largely resolved here since non-acetabular pelvis portions and acetabular portions for KRM1 are lumped to represent cut mark frequencies on pelves. This was done because Bunn and Kroll (1986) do not provide cut mark data for separate portions of the pelvis. This issue needs to be resolved for more credible interpretation. Nevertheless, for the lower non-meaty limb bones apart from the distal tibia, the cut mark data from KRM1 and FLK are not markedly different. A higher proportion of cut marks on distal tibiae at FLK suggests that hominids were expending more effort and/or employing a different strategy for disarticulating this element compared with hominids at KRM1. This may be due to either differential effort in disarticulation and filleting or differences in stone tool technology. Apart from the distal tibia, butchers generated roughly similar proportions of cut marks on lower non-meaty limb bones.

Figure 6.23 shows that concerning scapulae, humeri, pelves, and femora, it appears that KRM1 hominids were butchering and/or acquiring parts of small animal carcasses differently from hominids at FLK. Figure 6.23 indicates that hominids at KRM1 acquired scapulae and pelves with more meat attached than did hominids at FLK. Interestingly, the cut mark data suggest that FLK hominids extracted more meat from humeri than their descendants at KRM1. Concerning femora, hominids at KRM1 produced roughly equal proportions of cut marks on the proximal and distal ends, while FLK hominids focused on distal ends. This suggests that FLK hominids did not acquire femora with as much meat on them as did hominids at KRM. Instead, the cut mark data suggest that hominids at FLK were focusing on disarticulating femora from tibiae. Again, more detailed information on cut mark placement and orientation is required for more detailed interpretation.

Similar proportions of cut marks on non-meaty lower limb bones in both assemblages as well as in the MRM assemblage suggests that, when these elements were acquired, they retained similar amounts of meat and tissues at the three sites, hence the similarity in cut mark proportions. The discrepancies observed for the upper meaty limb bones is, therefore, in all likelihood due to differential amounts of flesh on the bones when they were acquired at the three sites. Hence, different levels of access.

Notwithstanding certain complicating factors (e.g., calculating MCF for pelvis portions and preservational biases), the proportional distribution of cut marks suggests that hominids at KRM1 acquired upper meaty limb bones - specifically scapulae, pelves, and femora - while these elements were still fleshed. The proportions of cuts on these elements at FLK suggest
that hominids acquired these parts after they were at least partly if not fully defleshed by non-hominid carnivores. Overall, hominids at KRM1 appear to have acquired small bovid carcasses before large amounts of meat was consumed by non-hominid carnivores. Hominids at FLK apparently acquired upper meaty limb bones of small animal carcasses after they were at least partly defleshed by non-hominid carnivores. The interpretation offered here is that hominids were at worst practicing an aggressive and active form of scavenging, and at best successfully hunting small animals at KRM1. On the other hand, hominids at FLK were commonly scavenging from carnivore kills after considerable amounts of flesh was consumed by non-hominid carnivores. Concerning the acquisition of small animal carcasses, hominids at KRM1 may be placed alongside successful predators and carnivores, while hominids at FLK are placed between successful predators and carnivores and the most marginal of scavengers.

It is remarkable that for the upper meaty limb bones, the cut mark pattern at KRM1 is roughly similar to that documented at MRM (see section 6.4.3), while the FLK cut mark data for the upper meaty limb bones is markedly different from both KRM1 and MRM (see section 6.3.3). More remarkably, the pattern of cut marks on lower non-meaty limb bones in the three assemblages are not dramatically different. The methodology employed here appears to successfully distinguish between different modes of butchery and more importantly, between different strategies of carcass acquisition. In answering the question set in section 6.5.1; the data presented here suggests that hominids at KRM1 were not butchering and acquiring carcasses in the same way as hominids at FLK. The KRM1 hominids were producing cut marks in a fashion more akin with modern humans at MRM. Apparently, hominids at KRM1 had acquired skills of group coordination and cooperation in efforts to successfully acquire complete carcasses of small animals before carnivores consumed large amounts of meat. The inclusion of stone points and blades with long cutting edges in the MSA toolkit, no doubt equipped hominids at KRM1 with the technology to successfully kill and butcher small bovids. Of course stone tipped spears are not the only possible medium for hunting and killing animals, but organic materials other than bone are generally not easily recovered or well preserved in MSA and earlier archaeological sites. The behavioural reconstruction from the cut mark pattern at KRM1 is in stark contrast with that for hominids at FLK, who apparently lacked an effective strategy for successfully hunting or gaining full and not even early access to carcasses of small animals. As Milo (1998) has suggested,
hominids at KRM1 were as near to behavioural modernity as they were to anatomical modernity.

![Proportional distribution of mean cut mark frequencies (MCF) and cut marked specimens (CP) across different anatomical loci on small bovid bones from KRM1 and FLK respectively.](image)

Figure 6.23. Proportional distribution of mean cut mark frequencies (MCF) and cut marked specimens (CP) across different anatomical loci on small bovid bones from KRM1 and FLK respectively.

### 6.5.3. Comparing cut mark data for large animals from KRM1 and FLK

A correlation analysis of the proportional distribution of cut marked pieces (FLK) and cut mark frequencies (KRM1) across different anatomical portions of the skeleton of large bovids shows that there is not a significant correlation between the two assemblages ($r_s = 0.33, P > 0.05$). Overall, this demonstrates that large animals were acquired and/or butchered differently at the two sites. I use the bar graph (Figure 6.24) for more detailed explanations of similarities and differences between the two assemblages.

The pelvis is not discussed because of complications already discussed above and because precise anatomical locations of cut marks on pelves from FLK were not presented by Bunn and Kroll (1986). It is not clear whether cuts on FLK pelves are clustered around acetabulae or on non-acetabular portions. The high proportions of cut marked pieces of pelves and proximal femora at FLK may be due to disarticulating these elements. More detailed information about anatomical placement of cut marks is required for more realistic interpretations.

The similarity in cut mark proportions between KRM1 and FLK lies at the non-meaty lower limb bones (Figure 6.24). As with small bovids discussed above, this implies that these
elements were acquired by hominids at KRM1 and hominids at FLK with similar quantities of meat attached. That similar cut mark proportions for these elements were documented in the MRM assemblage supports this proposal. The difference between KRM1 and FLK is in the proportions with which upper meaty limb bones are cut marked. KRM1 retains high proportions of cut marks on scapulae and humeri, and more or less equal proportions of cuts on proximal and distal femora, strongly suggesting that these parts were acquired with substantial quantities of meat attached. In section 6.3.3 I suggested that the pattern observed at KRM1 is not drastically different from that documented at MRM. On the other hand, FLK retains low proportions of cut marks on scapulae and the high proportion of cuts on humeri are on the distal end. The latter cuts may be the result of either filleting or disarticulation. In the absence of cuts on proximal humeri (even though they are poorly represented at FLK), however, it is likely that cuts on the distal end reflect disarticulation rather than filleting. As mentioned above, the high proportion of cuts on femora are located on the proximal end. Again these cuts may be the result of filleting or disarticulation and the absence of cuts on the distal end suggests that disarticulation is a strong possibility. While the highest proportions of cuts at KRM1 are on scapulae, humeri, and pelves, the highest proportions of cuts at FLK are on distal humeri, distal tibiae, pelves, and lower front limb bones (Figure 6.24). The concern with pelves has been discussed.

The above discussion presents compelling evidence that hominids at KRM1 were butchering and acquiring large animal carcasses very differently from hominids at FLK. That the pattern observed at KRM1 is not drastically different from that in the MRM assemblage is compelling evidence that hominids were acquiring large bovid carcasses before substantial quantities of meat were consumed by non-hominid carnivores. The situation at FLK is very different in that hominids appear to be gaining access to carcasses of large animals only after considerable quantities of meat were consumed by non-hominid carnivores. Hominids at KRM1 appear to have developed a hunting and/or scavenging strategy effective enough to gain access to parts of large carcasses with substantial amounts of meat, including parts high on the carnivore flesh consumption sequence (Blumenschine 1986a). In the discussion of small bovids above, I have alluded to the inclusion of hunting and specialized butchering equipment in the toolkit of MSA hominids, and the lack thereof in the FLK hominid toolkit. An effective hunting and/or scavenging strategy – evidenced by a cut mark pattern not dramatically different from that recorded at MRM - may require coordinated and cooperative group activity. As discussed above, the evolution towards a near modern form of social
behaviour appears present at KRM1 by around 100 000 years ago. Apparently hominids at FLK were not very successful in acquiring the meatiest parts of large bovid carcasses before large amounts of meat were consumed by non-hominid carnivores, and therefore these hominids do not appear to have developed the cooperative social skills apparently evident at KRM1. Hominids at KRM1 can be placed quite accurately, alongside the most successful non-hominid predators and carnivores, while hominids at FLK were situated somewhere between non-hominid predators and carnivores and the most marginal of scavengers.

![Proportional distribution of mean cut mark frequencies (MCF) and cut marked specimens (CP) across different anatomical loci on large bovid bones from KRM1 and FLK respectively.](image)

Figure 6.24. Proportional distribution of mean cut mark frequencies (MCF) and cut marked specimens (CP) across different anatomical loci on large bovid bones from KRM1 and FLK respectively.

Although anatomically not quite modern, hominids occupying KRM1 had acquired at least one trait regarded as part of the repertoire of modern human behaviour. At KRM1, hominids were apparently successfully gaining early access to certain parts of animal carcasses around 100 000 years ago. The theory that successful hunting or gaining relatively early access to carcasses was a relatively recent behavioural trait in human evolution is questioned by the cut mark data for small and large bovids in the KRM1 assemblage (contra e.g., Binford 1981, 1984c; Blumenschine 1986a; Klein 1995; Klein & Cruz-Uribe 1996; Marean 1989; Potts & Shipman 1981; Shipman 1986a). On the other hand, hominids at FLK were apparently not gaining early access to animal carcasses (contra Bunn & Kroll 1986), but were acquiring certain skeletal elements before they were entirely cleaned of tissues by the most marginal of scavengers.
CHAPTER 7

CONCLUSIONS

7.1. INTRODUCTION

Results from the actualistic butchery study conducted at MRM form the backbone of this dissertation. Such a detailed description of butchery and its material manifestation in the form of cut marks is not currently available in the literature. Although a great deal was learnt through butchery observations at MRM, I stress again that results presented here should not be perceived as the ‘Rosetta Stone’ for interpreting cut marked bones from archaeological sites. Many more problem orientated and well-controlled actualistic butchery studies are required to challenge and/or substantiate observations presented here. Rather, information obtained from the current study should be viewed as additional steps to achieve better and better approximations of the meaning of cut marks on animal bones and how these inform us about certain behaviours of humans and hominids across space and through time. Results and implications of the MRM study are applicable to most prehistoric archaeological sites where cut marks are present on bone surfaces. Below I summarize the most significant results that stemmed from this research and then make some suggestions for additional studies required in the field of actualistic butchery.

7.2. KEY RESULTS FROM ACTUALISTIC RESEARCH AT MRM

Lyman (1994b) argued that no one has shown a strong and direct correlation between the number of butchered bones and the number of butchered bones retaining cut marks. According to Lyman, therefore, cut marks may be ambiguous quantitative features of butchery. A regression analysis between the number of butchered bones and bones retaining cut marks in the MRM assemblage demonstrates a very strong and positive correlation between butchered bones and cut marked bones. As a result, I argue that cut marks are not ambiguous quantitative features of butchery, and that cut mark frequencies should be
considered as a critical variable for reconstructing strategies of carcass acquisition and butchery.

More than 60% of Binford's (1981) cut mark codes, which he called unambiguous indicators of limb bone disarticulation, were produced on limb bones in the MRM assemblage when animals were filleted and not disarticulated. The MRM study has therefore yielded numerous changes and additions to Binford’s (1981) interpretative framework for interpreting cut marks. Several researchers have used Binford’s (1981) cut marks and their associated functions for reconstructing butchery and carcass acquisition strategies of, among others, hominids in the Upper Pleistocene and Plio-Pleistocene. The observations made at MRM have profound implications for the use of Binford's behavioural correlates, and interpretations based on Binford’s framework require serious re-assessment. Researchers are cautioned against the use of Binford’s cut mark codes that proved ambiguous indicators of specific butchery activities through the MRM study. Numerous cut mark codes with unambiguous behavioural correlates were added to Binford’s (1981) inventory through actualistic studies at MRM. Although cut mark codes with unambiguous behavioural correlates, as presented in the inventory in chapter 4, may be used as a guide for interpreting cut marks, they require testing and/or corroboration through additional, well-controlled actualistic butchery studies.

Several researchers have used near epiphyseal and epiphyseal cut marks as indicators of carcass disarticulation and hence as evidence for carcass acquisition strategies. Mann-Whitney U-Tests applied to the MRM data show that it is only on epiphyses that cut mark frequencies increase when bones are filleted and disarticulated as opposed to when they are exclusively filleted. The use of near epiphyseal cut marks as indicators of carcass dismemberment is questioned as a result of observations made at MRM. Additionally, as alluded to above, filleting without any disarticulation produced cut marks both on and near epiphyses of bones in the MRM assemblage.

Although the anatomical placement of cut marks associated with particular activities is similar for small and large bovids, the MRM observations reveal that large bovid bones retain significantly more cut marks than the bones of smaller bovids. It follows that if small and large bovids were acquired in roughly the same condition (i.e., similarly fleshed), large bovid bones should retain significantly more cut marks than the bones of small bovids. If cut marked bones of small and large bovids from an archaeological site display similar frequencies of cut marks, then, in accordance with the MRM information, butchers did not
have equal access to carcasses of small and large animals. Similar proportional distributions of cut marks across different anatomical portions on small and large bovid bones would suggest that butchers employed similar butchery strategies for processing carcasses of different sizes. Along with the orientation and anatomical location of cut marks, cut mark frequencies and the proportional distribution of cut marks inform about carcass acquisition and butchery strategies.

To the best of my knowledge, no one has documented the presence and value of cut marks on the medial surfaces of rib shafts. These cuts are commonly produced in the MRM assemblage and are unambiguous indicators of evisceration. No meat is associated with the medial surfaces of ribs and cuts (with appropriate orientation, angulation and frequencies) in this zone can only be attributed to evisceration. Viscera are of the first animal tissues consumed in the carnivore consumption sequence and therefore, the presence of evisceration cut marks indicates access (by people or hominids) to carcasses before carnivores consumed considerable quantities of tissues. In sum, the presence of evisceration marks is a reliable indicator of the type of access hominids or people had to animal carcasses. Certain cuts on lumbar and thoracic vertebrae are also associated with evisceration.

Comparisons of the proportional distribution of cut mark frequencies from MRM and cut mark data from Cave 1 at Klasies River Mouth (Milo 1998) demonstrate that for many skeletal elements there is a significant correlation between the MRM and KRM1 assemblages. This is remarkable since so many variables are uncontrolled and unknown in the archaeological assemblage. In fact, even the mean cut mark frequencies (actual number of cuts per MNE) on small bovid bones are not significantly different for the MRM and KRM1 assemblages. Apparently, hominids at KRM1 had relatively early access to at least certain meaty bones before non-human carnivores consumed substantial amounts of tissues. According to comparisons of the cut mark information from the MRM and KRM1 assemblages, hominids at KRM1 were not marginal scavengers of tissues from small or large bovids, although they apparently had better access to carcasses of small animals relative to large ones. Smaller animals were possibly hunted or scavenged from tree-stored leopard kills, while large animal tissues from certain meaty limb bones were probably acquired most commonly through aggressive, confrontational scavenging. In the chain of meat-eaters, hominids can be placed among or just secondary to the most successful non-hominid carnivores.
When comparing the MRM cut mark data with those from FLK *Zinjanthropus*, the assemblages are not significantly correlated. Examination of the bar graphs presented in section 6.4, however, shows that for certain skeletal elements, particularly the lower non-meaty limb bones, the proportional distribution of cut marks and cut marked pieces are not markedly different. This suggests that hominids only gained access to animal carcasses after carnivores had consumed considerable quantities of meat and that hominids did not find scapulae, humeri, pelves, or femora fully fleshed. However, because the proportional distribution of cut marks on the lower limb bones are not markedly different from the pattern observed in the MRM data, hominids were gaining access to carcasses before bones were entirely cleaned and ravaged by non-hominid carnivores and scavengers. This indicates that hominids, in the chain of meat eaters, can be placed with reasonable confidence between successful non-hominid hunters and the most marginal of scavengers. If hominids were hunting, then the cut mark data suggest that they were not able to retain carcasses successfully since non-hominid carnivores were consuming tissues from elements ranking high in the carnivore consumption sequence. The same interpretation applies to both small and large animal bones from FLK. It seems more likely that hominids were scavenging after non-hominid predator consumption, but before complete consumption by marginal scavengers.

A correlation analysis of the proportional distribution of cut mark frequencies and cut marked bones from KRM1 and FLK demonstrates that there is not a significant correlation between the two assemblages. However, like with the comparison between MRM and FLK, the bar graphs indicate that cut mark frequencies and cut marked bones are not markedly different on the lower, non-meaty limb bones from KRM1 and FLK. Again, this strongly suggests that hominids at FLK had very different access to animal products compared with their Upper Pleistocene descendents at KRM1. KRM1 hominids had access to at least some parts ranking high on the carnivore consumption sequence while hominids at FLK apparently did not. The hominid butchery and carcass acquisition signature at KRM1 is more like that seen in the MRM assemblage relative to the FLK assemblage, while the FLK cut mark data are divergent from both the MRM and KRM1 assemblages. Apparently, hominids at KRM1 had acquired carcass acquisition and butchery strategies more akin with the modern condition, while hominids at FLK had relatively limited access to carcass parts of both small and large animals.
Interpretations of the cut mark data from KRM1 and FLK are preliminary, but the results demonstrate the interpretative potential of actualistic butchery studies like those conducted at MRM. Before more detailed interpretations of the KRM1 and FLK assemblages can be offered, certain methodological constraints require resolution. These include standardization of methods for recording, quantifying, analyzing and presenting cut mark data, as well as detailed presentation of precise location and orientation of cut marks. Such standardization is necessary to make archaeological and actualistic assemblages comparable. Additionally, larger samples of cut marked bones from hominid sites, recorded and quantified by current methods, are required to test or verify interpretations offered here.

Previous butchery studies, particularly those concerned with early hominid behaviour and the emergence of behavioural modernity, are burdened by attempts at providing evidence for either hunting or scavenging. In the archaeological record, unambiguous evidence for hunting is all but absent and I suggest that the placement of hominids in the sequence of meat-eaters is a more realistic and achievable objective than trying to distinguish between hunting and scavenging. Although the latter two activities are what we ultimately wish to identify and distinguish, particularly in the case of early hominid behaviour, it is important to establish hominids’ ability to acquire animal resources in relation to the abilities of other non-hominid carnivores. A feature that distinguishes us from non-human animals is our ability to control the natural environment. In researching hominid dietary evolution, it is important to establish whether early hominids were capable of manipulating and/or controlling other carnivores in establishing a dietary niche for themselves. In this scenario it is less important to establish which animal(s) tracked and immobilized prey and more important to establish which animal(s) controlled the access to animal resources. Once we know where hominids fit within the sequence of meat eaters, we can start developing models concerning the types of behaviours that were used to acquire animal carcasses. I demonstrated that the cut mark data, when viewed in tandem with the carnivore consumption sequence and utility indices enable me to place hominids in the chain of meat eaters and consequently, allows me to make some inferences regarding the manner in which animals were acquired. In considering strategies of carcass acquisition, it is important to bear in mind that anatomically and behaviourally modern hunter gatherers practice a combination of hunting and scavenging in acquiring resources from animal products, particularly large game. We may expect, therefore, that hominids did not practice a single strategy of carcass acquisition, but a combination of strategies as required by different circumstances. By using a combination of information,
such as cut marks, carnivore tooth marks, the carnivore consumption sequence, and utility indices, it may be possible to reconstruct mixed strategies of carcass acquisition, or strategies dominated by either early or late access. Through such reconstructions we may develop models about the status of either hunting or scavenging in hominid dietary behaviour.

7.3. SUGGESTIONS FOR FUTURE RESEARCH IN ACTUALISTIC BUTCHERY

Results from the MRM study have significant implications for butchery studies, particularly for reconstructing strategies of carcass acquisition and butchery as practiced by people and hominids. This applies to all archaeological assemblages predating the historical period. The obvious next step is to compare the MRM cut mark data with ethnographic and Later Stone Age assemblages where the butchers are anatomically and behaviourally modern, and where access to animal carcasses is not in doubt. Such comparisons will test the methodology employed in the current study and provide opportunities to modify it. To make the above-mentioned comparisons, cut mark data from actualistic, ethnographic and archaeological assemblages must be comparable and therefore, researchers are urged to record and present cut mark data according to current methods and guidelines presented in this study.

The most significant shortcomings of the MRM study are that; 1) the sample of butchered animals is fairly small, particularly the number of animals that were filleted and disarticulated, and 2) most butchery was conducted with metal tools. Additional problem orientated and well-controlled actualistic butchery studies are required to increase the sample size and hence variability and to determine the qualitative and quantitative differences between butchery with metal and stone tools and their resulting signatures. Further, comparing cut mark data for Iron Age and Later Stone Age faunal assemblages may shed light on differences in butchery strategies, and hence cut mark placement and frequencies, as a result of differences in tool technology. Experimental butchery as conducted at MRM has an advantage over ethnographically observed butchery in that activities can be controlled and separated in experimental settings. This circumvents the problem of untangling palimpsests of cut marks produced by disparate butchery activities. Recording butchery with a video camera prevents the interruption of butchery procedures and allows the researcher to return to the act at any time after the fact. I suggest, therefore, that there is an urgent need for additional actualistic butcheries carried out under experimental conditions, but that the
researcher does not perform the butchery, and that all butchery activities are filmed. Additional actualistic studies are required to determine whether analysts performing their own butchery have an effect on the anatomical placement of cut marks, and the proportional distribution of cut mark frequencies across different anatomical portions.

An additional aspect not dealt with in the MRM study is the anticipated variation in cut marks resulting from differences in culinary processes (e.g., Binford 1981, 1984b; Bunn 1983a; Bunn et al. 1988; Brain 1967b, 1969; Fiorillo 1989; Gifford-Gonzalez 1989a, 1989b, 1993; Jones 1993; Kent 1993; Oliver 1993; Yellen 1977b, 1991a). Resolution of this issue requires additional actualistic butcheries of roasted and boiled animal carcass parts. Through extensive experience with boiled units, I know that meat can be removed more readily after boiling animal units and therefore a reduction in cut marks is anticipated. On the other hand, roasting may have the effect of drying and contracting meat on bones and therefore make it more difficult to fillet. It is possible, therefore, that roasting will have a less significant effect on butchery and its resultant damage relative to boiling.

Detailed analysis of cut mark types and angulation as produced by different butchery activities is required to evaluate how these variables are affected by different butchery procedures. An evaluation of the interpretative potential of cut mark type and angulation is needed. Such distinguishing criteria will be particularly useful to identify specific butchery activities where different butchery procedures impact the same anatomical region.

The effects of fragmentation on cut mark frequencies have not been dealt with in any detail here, but actualistic research and/or innovative analytical techniques concerning this taphonomic process are clearly needed to develop methods for quantifying cut marks in such a way as to circumvent differential fragmentation and survival.

These suggestions for additional research into butchery are just a few examples that stem directly from the MRM study. Other issues which require additional actualistic research include, for example; the nature of the cut mark signature produced while preparing meat for drying as opposed to preparing meat for immediate consumption. The development of criteria for identifying meat drying will, for example, enable archaeologists to study the evolution of storage and delayed consumption of animal products. Another issue requiring additional actualistic research concerns cut mark patterning resulting from the sequencing of butchery activities such as initial dismemberment prior to filleting or initial filleting prior to dismemberment (e.g., Milo 1994). Sequencing of butchery activities, when viewed in
conjunction with utility indices, can inform us about factors such as field processing and transport costs and benefits.

Results from the MRM study show that actualistic butchery allows the construction of middle range hypotheses, to be tested through additional actualistic work, which can be used to interpret butchered bones from archaeological sites. Such interpretation, in turn, can be used to infer strategies of carcass acquisition and butchery practiced by people and hominids across space and through time. Through reconstructions of hominid dietary behaviour, archaeologists and palaeoanthropologists aim to establish, among other things, at what time hominids started consuming substantial quantities of meat and at what time hominids were acquiring animal carcasses in ways that resemble the modern condition. Carcass acquisition and butchery are just parts of the behavioural repertoire of hominids and people, but, among other topics, the accurate identification of specific dietary related behaviours enables researchers to develop models concerning the origins of meat-eating in the Plio-Pleistocene and the behavioural modernity, with respect to meat-eating, of hominids in the Upper-Pleistocene.

The work presented here has focused in great detail on a very small part, in fact on just a piece of the puzzle of hominid behaviour. Like scientists in other disciplines, archaeologists are becoming more and more specialized, and the MRM study is a reflection of such specialization. Along with other specialist studies, for example, in primate behaviour, isotopes or trace elements, microwear on hominid teeth and stone tool technology, this study provides details of a fragment of the ‘hominid picture’ as a means to developing a better understanding of human evolution.
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APPENDIX A

CODES FOR ANIMAL AND BONE DATA

**Bone Number:**
1, 2, 3, … This is a unique number for each bone in the study.

**Group Number:**
1. filleted springbok
2. springbok
3. black wildebeest
4. blesbok
5. filleted black wildebeest
6 - 10. eland
11. steenbok
12. filleted black wildebeest

**Species:**
AM = *Antidorcas marsupialis*
CG = *Connochaetes gnou*
DD = *Damaliscus dorcas phillipsi*
RC = *Raphicerus campestris*
TO = *Taurotragus oryx*

**Size Classes**
I = small
II = small-medium
III = medium-large
IV = large
V = very large
Side:
L = left
R = right
A = axial

Activity:
D = disarticulation
DPS = disarticulating pelvis from sacrum
DR = disarticulating ribs
E = evisceration
EDR = evisceration and disarticulating ribs
EF = evisceration and filleting
EFD = evisceration, filleting and disarticulation
F = filleting or defleshing
FD = filleting and disarticulation
FDR = filleting and disarticulating ribs
FEDDR = filleting, evisceration, disarticulation and disarticulating ribs
FEDR = filleting, evisceration and disarticulating ribs
RT = removal of tongue
S = skinning
SAF = sawing and filleting
SD = skinning and disarticulation
SF = skinning and filleting
SFD = skinning, disarticulation and filleting
SP = splitting pelvis

Butchering Tool:
ES = electric saw
ESM = electric saw and metal knife
M = metal knife
MS = metal knife and stone flake
S = stone flake
**Skeletal Element:**

AD = adiagnostic (PJN\textsuperscript{13})
CR = cranium (PJN)
OC = occipital condyle
MX = maxilla (PJN)
MD = mandible
AT = atlas
AX = axis
CE = cervical vertebra
TH = thoracic vertebra
LU = lumbar vertebrae
SA = sacrum
RI = ribs
FR = front ribs (PJN)
MR = middle ribs (PJN)
RR = rear ribs (PJN)
SC = scapula
HU = humerus
RU = radio-ulna (PJN)
RA = radius
UL = ulna
CA = carpals (PJN)
LN = lunate
MA = magnum
UN = unciform
PI = pisiform
SD = scaphoid
CU = cuneiform
CUUN = cuneiform and unciform (PJN)
SDMA = scaphoid and magnum (PJN)
IN = pelvis or innominate
FE = femur
PA = patella

\textsuperscript{13} Indicates codes I used that were not presented by Klein and Cruz-Uribe (1984). All other codes were presented by Klein and Cruz-Uribe (1984)
TI = tibia
TS = tarsals (PJN)
CA = calcaneum
TC = tuber calcis
AS = astragalus
C1 = external and middle cuneiform
C2 = internal cuneiform
NC = naviculo-cuboid (PJN)
LM = lateral malleolus or lateral metapodial
APPENDIX B

CODES FOR CUT MARK CLUSTER DATA

Bone number: same as described in Appendix A
Cluster number:
1, 2, 3, … This is a unique number for each cluster of cut marks on a particular specimen

View of Bone:
V = ventral
D = dorsal
CA = caudal
CR = cranial
L = left side view
R = right side view
P = proximal
DI = distal
AN = anterior
PO = posterior
ME = medial
LA = lateral
AM = anterio-medial
AL = anterio-lateral
PM = posterio-medial
PL = posterio-lateral

Anatomical Portion:
(also see skeletal element codes in Appendix A and figures in Appendix D)
PE = proximal epiphysis
PS = proximal shaft
MS = mid shaft
DS = distal shaft
DE = distal epiphysis
NE = near epiphyseal
EP = epiphyseal
WB = whole bone
SH = shaft
OC = occipital condyle
TE = squamous temporal
PA = parietal
NM = nasal/maxilla
NA = nasal
MA = maxilla
NL = nasal/lacrimal
PM = premaxilla
MP = mastoid process
BM = body of mandible
AR = ascending ramus
AM = angle of mandible
CP = coronoid process
MC = mandibular condyle
DT = dorsal tubercle
AW = atlas wing
CR = cranial articular surface
CA = caudal articular surface
VT = ventral tubercle
DW = dorsal wing
VW = ventral wing
SW = sacrum wing
DP = dorsal spine
RF = rib facet
VA = vertebral arch
VS = ventral spine
CRP = cranial articular process
CAP = caudal articular process
UCE = upper or superior centrum
LCE = lower or inferior centrum
CE = vertebral centrum
TP = transverse process
SIJ = sacro-iliac joint
PB = pubic symphysis
OL = olecranon
TC = tuber calcis

**Anatomical Features:**
AS = articular surface
NS = non-articular surface
MA = muscle attachment
NM = non-muscle attachment
LA = ligament attachment
NL = non-ligament attachment

**Orientation of Cluster/Activity (direction of butcher’s action):**
T = transverse
L = longitudinal
D = diagonal
LD = longitudinal to diagonal
DT = diagonal to transverse
TL = transverse to longitudinal
DTL = diagonal to transverse to longitudinal
APPENDIX C

CODES FOR INDIVIDUAL CUT MARK DATA AS USED IN ARCVIEW (GIS)

Bone number: same as described in Appendix A
Cluster number: same as described in Appendix B

Cut Mark Orientation:
1. transverse (perpendicular to longitudinal)
2. longitudinal
3. diagonal
4. longitudinal to diagonal
5. transverse to diagonal

Cut Mark Type (see section 3.6 and Figure D.27):
1. cut (incision made perpendicular to bone surface)
2. slice (incision made at angle to bone surface)
3. cut and shave
4. shave and cut
5. cut and shave and cut
6. shave and cut and shave
7. shave
8. scrape
9. puncture
10. puncture and drag
11. saw mark (sawn through)
12. crushed, damaged, or bone that is cut away
13. cut or incision with indeterminate angulation
14. notches, nicks
15. puncture and shave, puncture and cut
Angulation of Cut Mark (angle at which cutting tool penetrated the bone surface):

Note: colours denote the side from which the cutting tool penetrated the bone surface; blue = from right and green = from left.

1. 0°-45° (cut/shave [green])
2. 45°-90° (green)
3. 90° (solid black)
4. 90°-135° (blue)
5. 135°-180° (cut/shave [blue])
6. indeterminate (dotted black)
7. shaved from green
8. shaved from blue
APPENDIX D

FIGURES DISPLAYING SKELETAL PORTIONS AND CUT MARK TYPES
REFERRED TO IN TEXT
Figure D.1. (a) ventral, (b) dorsal and (c) caudal views of the cranium. OC = occipital condyle, PA = parietal, FR = frontal, LA = lacrimal, MA = maxilla, NA = nasal, PM = premaxilla, MP = paramastoid process.
Figure D.2. (a) right side and (b) left side views of the cranium. OC = occipital condyle, MP = paramastoid process, LA = lacrimal, PM = premaxilla, MA = maxilla, NA = nasal.
Figure D.3. (a) medial (lingual) and (b) lateral (buccal) views of the left mandible. MC = mandibular condyle, AR = ascending ramus, AM = angle of mandible, BM = body of mandible, CP = coronoid process.
Figure D.4. (a) dorsal, (b) ventral and (c) cranial views of the atlas. AW = atlas wing, CA = cranial articular surface, DT = dorsal tubercle, VT = ventral tubercle.
Figure D.5. (a) ventral, (b) dorsal, (c) right side and (d) left side views of the cervical vertebra. VW = ventral wing, CE = centrum, VS = ventral spine, LCE = lower centrum, UCE = upper centrum, TP = transverse process, CRP = cranial articular process, DW = dorsal wing, VA = vertebral arch, CAP = caudal articular process, DP = dorsal spine.
Figure D.6. (a) right side, (b) left side, (c) dorsal and (d) ventral views of the thoracic vertebra. TP = transverse process, VA = vertebral arch, UCE = upper centrum, CE = centrum, LCE = lower centrum, DP = dorsal spine, CRP = cranial articular process, CAP = caudal articular process, RF = rib facet.
Figure D.7. (a) cranial and (b) caudal views of the thoracic vertebra. DP = dorsal spine, TP = transverse process, CRP = cranial articular process, RF = rib facet, CE = centrum, VA = vertebral arch.
Figure D.8. (a) right side, (b) left side, (c) dorsal and (d) ventral views of the lumbar vertebra. CRP = cranial articular process, TP = transverse process, CE = centrum, LCE = lower centrum, VA = vertebral arch, UCE = upper centrum, CAP = caudal articular process, DP = dorsal spine.
Figure D.9. (a) ventral, (b) dorsal and (c) cranial views of the sacrum. CRP = cranial articular process, VA = vertebral arch, CAP = caudal articular process, CE = centrum, DP = dorsal spine, SW = sacrum wing.
Figure D.10. (a) right side and (b) left side views of the sacrum. CRP = cranial articular process, DP = dorsal spine, SIJ = sacro-iliac joint.
Figure D.11. (a) posterior, (b) lateral, (c) anterior and (d) medial views of the left scapula. SH = shaft, DS = distal shaft (neck), DE = distal epiphysis.
Figure D.12. Distal view of the left scapula. DE = distal epiphysis.
Figure D.13. (a) medial, (b) anterior, (c) lateral and (d) posterior views of the left humerus. PE = proximal epiphysis, PS = proximal shaft, MS = mid shaft, DS = distal shaft, DE = distal epiphysis.
Figure D.14. (a) proximal (proximal epiphysis), (b) distal (distal epiphysis) and (c) posterior views of the left humerus.
Figure D.15. (a) medial, (b) anterior, (c) lateral and (d) posterior views of the left radio-ulna. Dashed lines represent the radius and solid lines represent the ulna. OL = olecranon, PE = proximal epiphysis, PS = proximal shaft, MS = mid shaft, DS = distal shaft, DE = distal epiphysis.
Figure D.16. (a) proximal and (b) distal views of the left radio-ulna.
Figure D.17. (a) medial, (b) anterior, (c) lateral and (d) posterior views of the left carpal bones. PI = pisiform, SD = scaphoid, LN = lunate, CU = cuneiform, UN = unciform, MA = magnum.
Figure D.18. (a) ventral, (b) lateral, (c) dorsal and (d) medial views of the left pelvis. EP = epiphysis (acetabulum), PB = pubis symphysis, SIJ = sacro-iliac joint. Unmarked areas constitute SH (shaft) and NE (near epiphysial) portions of the element.
Figure D.19. (a) medial, (b) anterior, (c) lateral and (d) posterior views of the left femur. PE = proximal epiphysis, PS = proximal shaft, MS = mid shaft, DS = distal shaft, DE = distal epiphysis.
Figure D.20. (a) proximal, (b) oblique distal, (c) distal and (d) oblique proximal views of the left femur.
Figure D.21. (a) medial, (b) anterior, (c) lateral and (d) posterior views of the left tibia. PE = proximal epiphysis, PS = proximal shaft, MS = mid shaft, DS = distal shaft, DE = distal epiphysis.
Figure D.22. (a) proximal and (b) distal views of the left tibia.
Figure D.23. Anterior view of the left patella.
Figure D.24. (a) medial, (b) anterior, (c) lateral and (d) posterior views of the left tarsal bones. TC = tuber calcis, CA = calcaneum, LM = lateral malleolus, AS = astragalus, NC = naviculo-cuboid, C2 = internal cuneiform, C1 = external and middle cuneiform.
Figure D.25. (a) anterior and (b) distal views of the left astragalus.
Figure D.26. (a) medial, (b) lateral and (c) proximal views of the left 8th rib. PE = proximal epiphysis, PS = proximal shaft, MS = mid shaft, DS = distal shaft.
Figure D.27. Types of butchery marks as defined in section 3.6. are displayed here. Crush marks occur on rib heads as well as cranial and caudal aspects of thoracic vertebrae. Crush marks are presented in the same manner as shave or scrape marks. Saw marks normally extend across the entire bone surface and are sometimes represented by double lines.
AN ACTUALISTIC BUTCHERY STUDY IN SOUTH AFRICA AND ITS IMPLICATIONS FOR RECONSTRUCTING HOMINID STRATEGIES OF CARCASS ACQUISITION AND BUTCHERY IN THE UPPER PLEISTOCENE AND PLIO-PLEISTOCENE

(Volume 2)

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Thesis Presented for the Degree of

DOCTOR OF PHILOSOPHY

in the Department of Archaeology

UNIVERSITY OF CAPE TOWN

April 2000
APPENDIX E

FIGURES DISPLAYING CUT MARKS REFERRED TO IN CHAPTER 4
Figure 4.1. (a) ventral, (b) dorsal and (c) caudal views of cut marked small bovid cranium (MNE = 1). Cut marks produced by all butchery activities are depicted.
Figure 4.2. (a) right side and (b) left side views of cut marked small bovid cranium (MNE =1). Cut mark produced by all activities is depicted.
Figure 4.3. (a) ventral, (b) dorsal and (c) caudal views of cut marked small bovid cranium (MNE = 1). Cut marks produced by skinning are depicted.
Figure 4.4. (a) right side and (b) left side views of cut marked small bovid cranium (MNE = 1). Cut mark produced by skinning is depicted.
Figure 4.5. (a) ventral, (b) dorsal and (c) caudal views of cut marked small bovid cranium (MNE = 1). Cut marks produced by disarticulation are depicted.
Figure 4.6. (a) ventral, (b) dorsal and (c) caudal views of cut marked large bovid crania (MNE = 2). Cut marks produced by all butchery activities are depicted.
Figure 4.7. (a) right side and (b) left side views of cut marked large bovid crania (MNE = 2). Cut marks produced by all activities are depicted.
Figure 4.8. (a) ventral, (b) dorsal and (c) caudal views of cut marked large bovid crania (MNE = 2). Cut marks produced by disarticulation are depicted.
Figure 4.9. (a) right side and (b) left side views of cut marked large bovid crania (MNE = 2). Cut marks produced by disarticulation are depicted.
Figure 4.10. (a) ventral, (b) dorsal and (c) caudal views of cut marked large bovid crania (MNE = 2). Cut marks produced by skinning are depicted.
Figure 4.11. (a) right side and (b) left side views of cut marked large bovid crania (MNE = 2). Cut marks produced by skinning are depicted.
Figure 4.12. (a) ventral, (b) dorsal and (c) caudal views of cut marked large bovid crania (MNE = 2). Cut marks produced by skinning and filleting are depicted.
Figure 4.13. (a) right side and (b) left side views of cut marked large bovid crania (MNE = 2). Cut marks produced by skinning and filleting are depicted.
Figure 4.14. (a) right side and (b) left side views of cut marked large bovid crania (MNE = 2). Cut marks produced during skinning, filleting and disarticulation are depicted.
Figure 4.15. (a) medial (lingual) and (b) lateral (buccal) views of cut marked small bovid mandibles (MNE = 4). Cut marks produced by skinning, filleting, and disarticulation are depicted.
Figure 4.16. (a) medial (lingual) and (b) lateral (buccal) views of cut marked large bovid mandibles (MNE = 10). Cut marks produced by all butchery activities are depicted.
Figure 4.17. (a) medial (lingual) and (b) lateral (buccal) views of cut marked large bovid mandibles (MNE = 10). Cut marks produced during skinning, filleting and disarticulation are depicted.
Figure 4.18. (a) medial (lingual) and (b) lateral (buccal) views of cut marked large bovid mandibles (MNE = 10). Cut marks produced by skinning and filleting are depicted.
Figure 4.19. (a) medial (lingual) and (b) lateral (buccal) views of cut marked large bovid mandibles (MNE = 10). Cut marks produced by filleting and disarticulation are depicted.
Figure 4.20. (a) medial (lingual) and (b) lateral (buccal) view of cut marked large bovid mandibles (MNE = 10). Cut marks produced by disarticulation are depicted.
Figure 4.21. (a) medial (lingual) and (b) lateral (buccal) views of cut marked large bovid mandibles (MNE = 10). Cut marks produced by removal of the tongue are depicted.
Figure 4.22. (a) dorsal, (b) ventral and (c) cranial views of cut marked small bovid atlases (MNE = 8). Cut marks produced by all butchery activities are depicted.
Figure 4.23. (a) dorsal, (b) ventral and (c) cranial views of cut marked small bovid atlases (MNE = 8). Cut marks produced by disarticulation are depicted.
Figure 4.24. (a) dorsal, (b) ventral and cranial views of cut marked small bovid atlases (MNE = 8). Cut marks produced by filleting and disarticulation are depicted.
Figure 4.25. (a) dorsal, (b) ventral and (c) cranial views of cut marked small bovid atlases (MNE = 8). Cut marks produced by filleting and evisceration are depicted.
Figure 4.26. (a) dorsal, (b) ventral and (c) cranial views of cut marked large bovid atlases (MNE = 9). Cut marks produced by all activities are depicted.
Figure 4.27. (a) dorsal, (b) ventral and (c) cranial views of cut marked large bovid atlases (MNE = 9). Cut marks produced during disarticulation are depicted.
Figure 4.28. (a) dorsal, (b) ventral and (c) cranial views of cut marked large bovid atlases (MNE = 9). Cut marks produced by filleting and disarticulation are depicted.
Figure 4.29. (a) dorsal, (b) ventral and (c) cranial views of cut marked large bovid atlases (MNE = 9). Cut marks produced by filleting and evisceration are depicted.
Figure 4.30. (a) right side, (b) left side, (c) dorsal and (d) ventral views of cut marked small bovid axes (MNE = 8). Cut marks produced by filleting and evisceration are depicted.
Figure 4.31. (a) ventral, (b) dorsal, (c) right side and (d) left side views of cut marked small bovid cervical vertebrae (MNE = 20). Cut marks produced by all butchery activities are depicted.
Figure 4.32. (a) ventral, (b) dorsal, (c) right side and (d) left side views of cut marked small bovid cervical vertebrae (MNE = 1). Cut marks produced by disarticulation are depicted.
Figure 4.33. (a) ventral, (b) dorsal, (c) right side and (d) left side views of cut marked small bovid cervical vertebrae (MNE = 20). Cut marks produced by filleting and evisceration are depicted.
Figure 4.34. (a) right side, (b) left side, (c) dorsal and (d) ventral views of cut marked large bovid axes (MNE = 9). Cut marks produced by filleting and evisceration are depicted.
Figure 4.35. (a) ventral, (b) dorsal, (c) right side and (d) left side views of cut marked large bovid cervical vertebrae (MNE = 20). Cut marks produced by all butchery activities are depicted.
Figure 4.36. (a) cranial and (b) caudal views of cut marked large bovid cervical vertebrae (MNE = 20). Cut marks produced by all butchery activities are depicted.
Figure 4.37. (a) ventral, (b) dorsal, (c) right side and (d) left side views of cut marked large bovid cervical vertebrae (MNE = 2). Cut marks produced by sawing and filleting are depicted.
Figure 4.38. (a) ventral, (b) dorsal, (c) right side and (d) left side views of cut marked large bovid cervical vertebrae (MNE = 6). Cut marks produced by disarticulation are depicted.
Figure 4.39. (a) cranial and (b) caudal views of cut marked large bovid cervical vertebrae (MNE = 6). Cut marks produced by disarticulation are depicted.
Figure 4.40. (a) ventral, (b) dorsal, (c) right side and (d) left side views of cut marked large bovid cervical vertebrae (MNE = 6). Cut marks produced by filleting, evisceration, and disarticulation are depicted.
Figure 4.41. (a) cranial and (b) caudal views of cut marked large bovid cervical vertebrae (MNE = 6). Cut marks produced by filleting and disarticulation are depicted.
Figure 4.42. (a) ventral, (b) dorsal, (c) right side and (d) left side views of cut marked large bovid cervical vertebrae (MNE = 20). Cut marks produced by filleting and evisceration are depicted.
Figure 4.43. (a) right side, (b) left side, (c) dorsal and (d) ventral views of cut marked small bovid front thoracic vertebrae (MNE = 8). Cut marks produced by all butchery activities are depicted.
Figure 4.44. (a) cranial and (b) caudal views of cut marked small bovid front thoracic vertebrae (MNE = 8). Cut marks produced by all butchery activities are depicted.
Figure 4.45. (a) right side, (b) left side, (c) dorsal and (d) ventral views of cut marked small bovid rear thoracic vertebrae (MNE = 3). Cut marks produced by all butchery activities are depicted.
Figure 4.46. (a) right side, (b) left side, (c) dorsal and (d) ventral views of cut marked small bovid front thoracic vertebrae (MNE = 8). Cut marks produced by evisceration are depicted.
Figure 4.47. (a) right side, (b) left side, (c) dorsal and (d) ventral views of cut marked small bovid rear thoracic vertebrae (MNE = 3). Cut marks produced by evisceration are depicted.
Figure 4.48. (a) right side, (b) left side, (c) dorsal and (d) ventral views of cut marked small bovid front thoracic vertebrae (MNE = 8). Cut mark produced by evisceration and/or filleting is depicted.
Figure 4.49. (a) right side, (b) left side, (c) dorsal and (d) ventral views of cut marked small bovid front thoracic vertebrae (MNE = 1). Cut marks produced by evisceration and/or disarticulating ribs are depicted.
Figure 4.50. (a) right side, (b) left side, (c) dorsal and (d) ventral views of cut marked small bovid front thoracic vertebrae (MNE = 8). Cut marks produced by filleting are depicted.
Figure 4.51. (a) right side, (b) left side, (c) dorsal and (d) ventral views of cut marked small bovid rear thoracic vertebrae (MNE = 3). Cut marks produced by filleting are depicted.
Figure 4.52. (a) right side, (b) left side, (c) dorsal and (d) ventral views of cut marked small bovid front thoracic vertebrae (MNE = 1). Cut marks produced by filleting and/or disarticulating ribs are depicted.
Figure 4.53. (a) cranial and (b) caudal views of cut marked small bovid front thoracic vertebrae (MNE = 1). Cut marks produced by filleting and/or disarticulating ribs are depicted.
Figure 4.54. (a) cranial and (b) caudal views of cut marked small bovid front thoracic vertebrae (MNE = 1). Cut marks produced by disarticulating ribs are depicted.
Figure 4.55. (a) right side, (b) left side, (c) dorsal and (d) ventral views of cut marked large bovid front thoracic vertebrae (MNE = 25). Cut marks produced by all butchery activities are depicted.
Figure 4.56. (a) cranial and (b) caudal views of cut marked large bovid front thoracic vertebrae (MNE = 25). Cut marks produced by all butchery activities are depicted.
Figure 4.57. (a) right side, (b) left side, (c) dorsal and (d) ventral views of cut marked large bovid rear thoracic vertebrae (MNE = 11). Cut marks produced by all butchery activities are depicted.
Figure 4.58. (a) cranial and (b) caudal views of cut marked large bovid rear thoracic vertebrae (MNE = 11). Cut marks produced by all butchery activities are depicted.
Figure 4.59. (a) right side, (b) left side, (c) dorsal and (d) ventral views of cut marked large bovid front thoracic vertebrae (MNE = 25). Cut marks produced by evisceration are depicted.
Figure 4.60. (a) right side, (b) left side, (c) dorsal and (d) ventral views of cut marked large bovid rear thoracic vertebrae (MNE = 11). Cut marks produced by evisceration are depicted.
Figure 4.61. (a) right side, (b) left side, (c) dorsal and (d) ventral views of cut marked large bovid front thoracic vertebrae (MNE = 25). Cut marks produced by evisceration and/or filleting are depicted.
Figure 4.62. (a) right side, (b) left side, (c) dorsal and (d) ventral views of cut marked large bovid rear thoracic vertebrae (MNE = 4). Cut marks produced by evisceration, and/or filleting and/or disarticulation are depicted.
Figure 4.63. (a) right side, (b) left side, (c) dorsal and (d) ventral views of cut marked large bovid front thoracic vertebrae (MNE = 8). Cut marks produced by evisceration and/or disarticulating ribs are depicted.
Figure 4.64. (a) right side, (b) left side, (c) dorsal and (d) ventral views of cut marked large bovid rear thoracic vertebrae (MNE = 4). Cut marks produced by evisceration and/or disarticulating ribs are depicted.
Figure 4.65. (a) right side, (b) left side, (c) dorsal and (d) ventral views of cut marked large bovid front thoracic vertebrae (MNE = 8). Cut marks produced by disarticulation are depicted.
Figure 4.66. (a) right side, (b) left side, (c) dorsal and (d) ventral views of cut marked large bovid rear thoracic vertebrae (MNE = 4). Cut marks produced by disarticulation are depicted.
Figure 4.67. (a) cranial and (b) caudal views of cut marked large bovid front thoracic vertebrae (MNE = 3). Cut marks produced by disarticulation and disarticulating ribs are depicted.
Figure 4.68. (a) right side, (b) left side, (c) dorsal and (d) ventral views of cut marked large bovid rear thoracic vertebrae (MNE = 4). Cut marks produced by disarticulation and/or disarticulating ribs are depicted.
Figure 4.69. (a) cranial and (b) caudal views of cut marked large bovid rear thoracic vertebrae (MNE = 4). Cut marks produced by disarticulation and/or disarticulating ribs are depicted.
Figure 4.70. (a) right side, (b) left side, (c) dorsal and (d) ventral views of cut marked large bovid front thoracic vertebrae (MNE = 25). Cut marks produced by filleting are depicted.
Figure 4.71. (a) cranial and (b) caudal views of cut marked large bovid front thoracic vertebrae (MNE = 25). Cut marks produced by filleting are depicted.
Figure 4.72. (a) right side, (b) left side, (c) dorsal and (d) ventral views of cut marked large bovid rear thoracic vertebrae (MNE = 11). Cut marks produced by filleting are depicted.
Figure 4.73. (a) cranial and (b) caudal views of cut marked large bovid rear thoracic vertebrae (MNE = 11). Cut marks produced by filleting are depicted.
Figure 4.74. (a) right side, (b) left side, (c) dorsal and (d) ventral views of cut marked large bovid front thoracic vertebrae (MNE = 8). Cut marks produced by filleting and/or disarticulating ribs are depicted.
Figure 4.75. (a) cranial and (b) caudal views of cut marked small bovid front thoracic vertebrae (MNE = 8). Cut marks produced by filleting and/or disarticulation are depicted.
Figure 4.76. (a) right side, (b) left side, (c) dorsal and (d) ventral views of cut marked large bovid rear thoracic vertebrae (MNE = 4). Cut marks produced by filleting and/or disarticulating ribs are depicted.
Figure 4.77. (a) right side, (b) left side, (c) dorsal and (d) ventral views of cut marked large bovid front thoracic vertebrae (MNE = 8). Cut marks produced by disarticulating ribs are depicted.
Figure 4.78. (a) cranial and (b) caudal views of cut marked large bovid front thoracic vertebrae (MNE = 8). Cut marks produced by disarticulating ribs are depicted.
Figure 4.79. (a) right side, (b) left side, (c) dorsal and (d) ventral views of cut marked large bovid rear thoracic vertebrae (MNE = 4). Cut marks produced by disarticulating ribs are depicted.
Figure 4.80. (a) cranial and (b) caudal views of cut marked large bovid rear thoracic vertebrae (MNE = 4). Cut marks produced by disarticulating ribs are depicted.
Figure 4.81. (a) right side, (b) left side, (c) dorsal and (d) ventral views of cut marked small bovid lumbar vertebrae (MNE = 3). Cut marks produced by all butchery activities are depicted.
Figure 4.82. (a) right side, (b) left side, (c) dorsal and (d) ventral views of cut marked small bovid lumbar vertebrae (MNE = 3). Cut mark produced by evisceration is depicted.
Figure 4.83. (a) right side, (b) left side, (c) dorsal and (d) ventral views of cut marked small bovid lumbar vertebrae (MNE = 3). Cut mark produced by evisceration and/or filleting is depicted.
Figure 4.84. (a) right side, (b) left side, (c) dorsal and (d) ventral views of cut marked small bovid lumbar vertebrae (MNE = 1). Cut marks produced by evisceration, and/or filleting and/or disarticulation are depicted.
Figure 4.85. (a) right side, (b) left side, (c) dorsal and (d) ventral views of cut marked small bovid lumbar vertebrae (MNE = 3). Cut marks produced by filleting are depicted.
Figure 4.86. (a) right side, (b) left side, (c) dorsal and (d) ventral views of cut marked large bovid lumbar vertebrae (MNE = 23). Cut marks produced by all butchery activities are depicted.
Figure 4.87. (a) cranial and (b) caudal views of cut marked large bovid lumbar vertebrae (MNE = 23). Cut marks produced by all butchery activities are depicted.
Figure 4.88. (a) right side, (b) left side, (c) dorsal and (d) ventral views of cut marked large bovid lumbar vertebrae (MNE = 23). Cut marks produced by evisceration are depicted.
Figure 4.89. (a) right side, (b) left side, (c) dorsal and (d) ventral views of cut marked large bovid lumbar vertebrae (MNE = 23). Cut marks produced by evisceration and/or filleting are depicted.
Figure 4.90. (a) right side, (b) left side, (c) dorsal and (d) ventral views of cut marked large bovid lumbar vertebrae (MNE = 5). Cut marks produced by evisceration, and/or filleting and/or disarticulation are depicted.
Figure 4.91. (a) right side, (b) left side, (c) dorsal and (d) ventral views of cut marked large bovid lumbar vertebrae (MNE = 23). Cut marks produced by filleting are depicted.
Figure 4.92. (a) right side, (b) left side, (c) dorsal and (d) ventral views of cut marked large bovid lumbar vertebrae (MNE = 5). Cut marks produced by filleting and/or disarticulation are depicted.
Figure 4.93. (a) right side, (b) left side, (c) dorsal and (d) ventral views of cut marked large bovid lumbar vertebrae (MNE = 2). Marks produced by sawing and filleting are depicted.
Figure 4.94. (a) right side, (b) left side, (c) dorsal and (d) ventral views of cut marked large bovid lumbar vertebrae (MNE = 5). Cut marks produced by disarticulation are depicted.
Figure 4.95. (a) cranial and (b) caudal views of cut marked large bovid lumbar vertebrae (MNE = 5). Cut marks produced by disarticulation are depicted.
Figure 4.96. (a) ventral, (b) dorsal and (c) cranial views of cut marked small bovid sacra (MNE = 9). Cut marks produced by all butchery activities are depicted.
Figure 4.97. (a) right side and (b) left side views of cut marked small bovid sacra (MNE = 9). Cut marks produced by all butchery activities are depicted.
Figure 4.98. (a) ventral, (b) dorsal and (c) cranial views of cut marked small bovid sacra (MNE = 9). Cut marks produced by filleting and evisceration are depicted.
Figure 4.99. (a) ventral, (b) dorsal and (c) cranial views of cut marked small bovid sacrum (MNE = 1). Cut marks produced by disarticulation are depicted.
Figure 4.100. (a) right side and (b) left side views of cut marked large bovid sacra (MNE = 9). Cut marks produced by all butchery activities are depicted.
Figure 4.101. (a) ventral, (b) dorsal and (c) cranial views of cut marked large bovid sacra (MNE = 9). Cut marks produced by all butchery activities are depicted.
Figure 4.102. (a) ventral, (b) dorsal and (c) cranial views of cut marked large bovid sacra (MNE = 9). Cut marks produced by evisceration and/or filleting are depicted.
Figure 4.103. (a) right side and (b) left side views of cut marked large bovid sacra (MNE = 9). Cut marks produced by filleting are depicted.
Figure 4.104. (a) ventral, (b) dorsal and (c) cranial views of cut marked large bovid sacra (MNE = 9). Cut marks produced by filleting are depicted.
Figure 4.105. (a) ventral, (b) dorsal and (c) cranial views of cut marked large bovid sacra (MNE = 5). Cut marks produced by filleting and/or disarticulation are depicted.
Figure 4.106. (a) right side and (b) left side views of cut marked large bovid sacra (MNE = 5). Cut marks produced by disarticulation are depicted.
Figure 4.107. (a) ventral, (b) dorsal and (c) cranial views of cut marked large bovid sacra (MNE = 5). Cut marks produced by disarticulation are depicted.
Figure 4. 108. (a) posterior, (b) lateral, (c) anterior and (d) medial views of cut marked small bovid scapulae (MNE = 12). Cut marks produced by filleting are depicted.
Figure 4. 109. (a) posterior, (b) lateral, (c) anterior and (d) medial views of cut marked large bovid scapulae (MNE = 18). Cut marks produced by all activities are depicted.
Figure 4.110. Distal view of cut marked large bovid scapulae (MNE = 18). Cut marks produced by all activities are depicted.
Figure 4.111. (a) posterior, (b) lateral, (c) anterior and (d) medial views of cut marked large bovid scapulae (MNE = 18). Cut marks produced by filleting are depicted.
Figure 4.112. Distal view of cut marked large bovid scapulae (MNE = 18). Cut marks produced by filleting are depicted.
Figure 4.113. (a) posterior, (b) lateral, (c) anterior and (d) medial views of cut marked large bovid scapulae (MNE = 3). Cut marks produced by filleting and disarticulation are depicted.
Figure 4.114. Distal view of cut marked large bovid scapulae (MNE = 3). Cut marks produced by filleting and disarticulation are depicted.
Figure 4.115. (a) medial, (b) anterior, (c) lateral and (d) posterior views of cut marked small bovid humeri (MNE = 12). Cut marks produced by all butchery activities are depicted.
Figure 4.116. (a) proximal, (b) distal and (c) posterior views of cut marked small bovid humeri (MNE = 12). Cut marks produced by all butchery activities are depicted.
Figure 4.117. (a) medial, (b) anterior, (c) lateral and (d) posterior views of cut marked small bovid humeri (MNE = 12). Cut marks produced by filleting are depicted.
Figure 4.118. (a) proximal, (b) distal and (c) posterior views of cut marked small bovid humeri (MNE = 12). Cut marks produced by filleting are depicted.
Figure 4.119. (a) medial, (b) anterior, (c) lateral and (d) posterior views of cut marked small bovid humerus (MNE = 1). Cut marks produced by filleting and disarticulation are depicted.
Figure 4.120. (a) proximal, (b) distal and (c) posterior views of cut marked small bovid humerus (MNE = 1). Cut marks produced by filleting and disarticulation are depicted.
Figure 4.121. (a) medial, (b) anterior, (c) lateral and (d) posterior views of cut marked large bovid humeri (MNE = 18). Cut marks produced by all butchery activities are depicted.
Figure 4.122. (a) proximal, (b) distal and (c) posterior view of cut marked large bovid humeri (MNE = 18). Cut marks produced by all activities are depicted.
Figure 4.123. (a) medial, (b) anterior, (c) lateral and (d) posterior view of cut marked large bovid humeri (MNE = 18). Cut marks, except those shown by arrows, were produced by filleting.
Figure 4.124. (a) proximal, (b) distal and (c) posterior view of cut marked large bovid humeri (MNE = 18). Cut marks produced by filleting are depicted.
Figure 4.125. (a) medial, (b) anterior, (c) lateral and (d) posterior views of cut marked large bovid humeri (MNE = 3). Cut marks produced by filleting and disarticulation are depicted.
Figure 4.126. (a) proximal, (b) distal and (c) posterior views of cut marked large bovid humeri (MNE = 3). Cut marks produced by filleting and disarticulation are depicted.
Figure 4.127. (a) medial, (b) anterior, (c) lateral and (d) posterior views of cut marked small bovid radii (MNE = 12). Cut marks produced by all butchery activities are depicted.
Figure 4.128. (a) proximal and (b) distal views of cut marked small bovid radii (MNE = 12). Cut marks produced by all butchery activities are depicted.
Figure 4.129. (a) medial, (b) anterior, (c) lateral and (d) posterior views of cut marked small bovid radii (MNE = 12). Cut marks produced by skinning and filleting are depicted.
Figure 4.130. (a) medial, (b) anterior, (c) lateral and (d) posterior views of cut marked small bovid radii (MNE = 12). Cut mark produced by filleting is depicted.
Figure 4.131. (a) proximal and (b) distal views of cut marked small bovid radius (MNE = 1). Cut marks produced by disarticulation are depicted.
Figure 4.132. (a) medial, (b) anterior, (c) lateral and (d) posterior views of cut marked large bovid radii (MNE = 18). Cut marks produced by all butchery activities are depicted.
Figure 4.133. (a) proximal and (b) distal views of cut marked large bovid radii (MNE = 18). Cut marks produced by all butchery activities are depicted.
Figure 4.134. (a) medial, (b) anterior, (c) lateral and (d) posterior views of cut marked large bovid radii (MNE = 18). Cut marks produced by skinning and filleting are depicted.
Figure 4.135. (a) proximal and (b) distal views of cut marked large bovid radii (MNE = 18). Cut marks produced by skinning and filleting are depicted.
Figure 4.136. (a) medial, (b) anterior, (c) lateral and (d) posterior views of cut marked large bovid radii (MNE = 3). Cut marks produced by skinning, filleting and disarticulation are depicted.
Figure 4.137. (a) medial, (b) anterior, (c) lateral and (d) posterior views of cut marked large bovid radii (MNE = 3). Cut marks produced by disarticulation are depicted.
Figure 4.138. (a) medial, (b) anterior, (c) lateral and (d) posterior views of cut marked large bovid radius (MNE = 1). Mark produced by sawing is depicted.
Figure 4.139. (a) medial, (b) anterior, (c) lateral and (d) posterior views of cut marked small bovid ulnae (MNE = 12). Cut marks produced by all butchery activities are depicted.
Figure 4.140. (a) medial, (b) anterior, (c) lateral and (d) posterior views of cut marked small bovid ulnae (MNE = 12). Cut marks produced by skinning and filleting are depicted.
Figure 4.141. (a) medial, (b) anterior, (c) lateral and (d) posterior views of cut marked small bovid ulna (MNE = 1). Cut marks produced by disarticulation are depicted.
Figure 4.142. (a) medial, (b) anterior, (c) lateral and (d) posterior views of cut marked large bovid ulnae (MNE = 18). Cut marks produced by all butchery activities are depicted.
Figure 4.143. (a) proximal and (b) distal views of cut marked large bovid ulnae (MNE = 18). Cut marks produced by all butchery activities are depicted.
Figure 4.144. (a) medial, (b) anterior, (c) lateral and (d) posterior views of cut marked large bovid ulnae (MNE = 3). Cut mark produced by skinning, filleting and disarticulation is depicted.
Figure 4.145. (a) proximal and (b) distal views of cut marked large bovid ulnae (MNE = 3). Cut marks produced by skinning, filleting and disarticulation are depicted.
Figure 4.146. (a) medial, (b) anterior, (c) lateral and (d) posterior views of cut marked large bovid ulnae (MNE = 18). Cut marks produced by skinning and filleting are depicted.
Figure 4.147. (a) proximal and (b) distal views of cut marked large bovid ulnae (MNE = 18). Cut marks produced by skinning and filleting are depicted.
Figure 4.148. (a) medial, (b) anterior, (c) lateral and (d) posterior views of cut marked large bovid ulnae (MNE = 3). Cut marks produced by disarticulation are depicted.
Figure 4.149. (a) medial, (b) anterior, (c) lateral and (d) posterior views of cut marked large bovid ulna (MNE = 1). Cut marks produced by sawing are depicted.
Figure 4.150. (a) medial, (b) anterior, (c) lateral and (d) posterior views of cut marked small bovid carpals (MNE = 12 sets or 50 carpal bones). Cut marks produced by disarticulation and skinning are depicted.
Figure 4.151. (a) medial, (b) anterior, (c) lateral and (d) posterior views of cut marked small bovid carpals (MNE = 12 sets or 50 carpal bones). Cut marks produced by disarticulation are depicted.
Figure 4.152. (a) medial, (b) anterior, (c) lateral and (d) posterior views of cut marked small bovid carpals (MNE = 12 sets or 50 carpal bones). Cut mark produced by skinning is depicted.
Figure 4.153. (a) medial, (b) anterior, (c) lateral and (d) posterior views of cut marked large bovid carpals (MNE = 18 sets or 94 carpal bones). Cut marks produced by skinning and disarticulation are depicted.
Figure 4.154. (a) medial, (b) anterior, (c) lateral and (d) posterior views of cut marked large bovid carpals (MNE = 18 sets or 94 carpal bones). Cut marks produced by disarticulation are depicted.
Figure 4.155. (a) medial, (b) anterior, (c) lateral and (d) posterior views of cut marked large bovid carpals (MNE = 18 sets or 94 carpal bones). Cut marks produced by skinning and disarticulation are depicted.
Figure 4.156. (a) ventral, (b) lateral, (c) dorsal and (d) medial views of cut marked small bovid pelves (MNE = 18). Cut marks produced by all butchery activities are depicted.
Figure 4.157. (a) ventral, (b) lateral, (c) dorsal and (d) medial views of cut marked small bovid pelves (MNE = 14). Cut marks produced by splitting the pelvis are depicted.
Figure 4.158. (a) ventral, (b) lateral, (c) dorsal and (d) medial views of cut marked small bovid pelves (MNE = 11). Cut marks produced by disarticulating the pelvis from the sacrum are depicted.
Figure 4.159. (a) ventral, (b) lateral, (c) dorsal and (d) medial views of cut marked small bovid pelves (MNE = 18). Cut marks produced by filleting are depicted.
Figure 4.160. (a) ventral, (b) lateral, (c) dorsal and (d) medial views of cut marked small bovid pelvis (MNE = 1). Cut marks produced by filleting and disarticulation are depicted.
Figure 4.161. (a) ventral, (b) lateral, (c) dorsal and (d) medial views of cut marked small bovid pelvis (MNE = 1). Cut mark produced by disarticulation is depicted.
Figure 4.162. (a) ventral, (b) lateral, (c) dorsal and (d) medial views of cut marked large bovid pelves (MNE = 18). Cut marks produced by all butchery activities are depicted.
Figure 4.163. (a) ventral, (b) lateral, (c) dorsal and (d) medial views of cut marked large bovid pelves (MNE = 12). Cut marks produced by splitting the pelvis are depicted.
Figure 4.164. (a) ventral, (b) lateral, (c) dorsal and (d) medial views of cut marked large bovid pelves (MNE = 12). Cut marks produced by disarticulating the pelvis from the sacrum are depicted.
Figure 4.165. (a) ventral, (b) lateral, (c) dorsal and (d) medial views of cut marked large bovid pelves (MNE = 18). Cut marks produced by filleting are depicted.
Figure 4.166. (a) ventral, (b) lateral, (c) dorsal and (d) medial views of cut marked large bovid pelves (MNE = 4). Cut marks produced by disarticulation are depicted.
Figure 4.167. (a) ventral, (b) lateral, (c) dorsal and (d) medial views of cut marked large bovid pelves (MNE = 4). Cut marks produced by filleting and disarticulation are depicted.
Figure 4.168. (a) medial, (b) anterior, (c) lateral and (d) posterior views of cut marked small bovid femora (MNE = 16). Cut marks produced by all butchery activities are depicted.
Figure 4.169. (a) proximal, (b) oblique distal, (c) distal and (d) oblique proximal views of cut marked small bovid femora (MNE = 16). Cut marks produced by all butchery activities are depicted.
Figure 4.170. (a) medial, (b) anterior, (c) lateral and (d) posterior views of cut marked small bovid femora (MNE = 16). Cut marks produced by filleting are depicted.
Figure 4.171. (a) proximal, (b) oblique distal, (c) distal and (d) oblique proximal views of cut marked small bovid femora (MNE = 16). Cut marks produced by filleting are depicted.
Figure 4.172. (a) medial, (b) anterior, (c) lateral and (d) posterior views of cut marked small bovid femur (MNE = 1). Cut marks produced by filleting and disarticulation are depicted.
Figure 4.173. (a) proximal, (b) oblique distal, (c) distal and (d) oblique proximal views of cut marked small bovid femur (MNE = 1). Cut marks produced by disarticulation are depicted.
Figure 4.174. (a) medial, (b) anterior, (c) lateral and (d) posterior views of cut marked large bovid femora (MNE = 18). Cut marks produced by all butchery activities are depicted.
Figure 4.175. (a) proximal, (b) oblique distal, (c) distal and (d) oblique proximal views of cut marked large bovid femora (MNE = 18). Cut marks produced by all butchery activities are depicted.
Figure 4.176. (a) medial, (b) anterior, (c) lateral and (d) posterior views of cut marked large bovid femora (MNE = 18). Cut marks produced by filleting are depicted.
Figure 4.177. (a) proximal, (b) oblique distal, (c) distal and (d) oblique proximal views of cut marked large bovid femora (MNE = 18). Cut marks produced by filleting are depicted.
Figure 4.178. (a) medial, (b) anterior, (c) lateral and (d) posterior views of cut marked large bovid femora (MNE = 4). Cut marks produced by filleting and disarticulation are depicted.
Figure 4.179. (a) proximal, (b) oblique distal, (c) distal and (d) oblique proximal views of cut marked large bovid femora (MNE = 4). Cut marks produced by filleting and disarticulation are depicted.
Figure 4.180. (a) medial, (b) anterior, (c) lateral and (d) posterior views of cut marked large bovid femora (MNE = 4). Cut marks produced by filleting and disarticulation are depicted.
Figure 4.181. (a) proximal, (b) oblique distal, (c) distal and (d) oblique proximal views of cut marked large bovid femora (MNE = 4). Cut marks produced by filleting disarticulation are depicted.
Figure 4.182. (a) medial, (b) anterior, (c) lateral and (d) posterior views of cut marked large bovid femur (MNE = 1). Marks produced by sawing are depicted.
Figure 4.183. (a) medial, (b) anterior, (c) lateral and (d) posterior views of cut marked small bovid tibiae (MNE = 16). Cut marks produced by all butchery activities are depicted.
Figure 4.184. (a) proximal and (b) distal views of cut marked small bovid tibiae (MNE = 16). Cut marks produced by all butchery activities are depicted.
Figure 4.185. (a) medial, (b) anterior, (c) lateral and (d) posterior views of cut marked small bovid tibiae (MNE = 16). Cut marks produced by filleting are depicted.
Figure 4.186. (a) medial, (b) anterior, (c) lateral and (d) posterior views of cut marked small bovid tibia (MNE = 1). Cut mark produced by filleting and disarticulation is depicted.
Figure 4.187. (a) proximal and (b) distal views of cut marked small bovid tibia (MNE = 1). Cut marks produced by filleting and disarticulation are depicted.
Figure 4.188. (a) medial, (b) anterior, (c) lateral and (d) posterior views of cut marked large bovid tibiae (MNE = 18). Cut marks produced by all butchery activities are depicted.
Figure 4.189. (a) proximal and (b) distal views of cut marked large bovid tibiae (MNE = 18). Cut marks produced by all butchery activities are depicted.
Figure 4.190. (a) medial, (b) anterior, (c) lateral and (d) posterior views of cut marked large bovid tibiae (MNE = 18). Cut marks produced by filleting are depicted.
Figure 4.191. (a) proximal and (b) distal views of cut marked large bovid tibiae (MNE = 18). Cut mark produced by filleting is depicted.
Figure 4.192. (a) medial, (b) anterior, (c) lateral and (d) posterior views of cut marked large bovid tibiae (MNE = 4). Cut marks produced by skinning, filleting, and disarticulation are depicted.
Figure 4.193. (a) proximal and (b) distal views of cut marked large bovid tibiae (MNE = 4). Cut marks produced by skinning, filleting and disarticulation are depicted.
Figure 4.194. (a) medial, (b) anterior, (c) lateral and (d) posterior views of cut marked large bovid tibiae (MNE $= 4$). Cut marks produced by disarticulation are depicted.
Figure 4.195. (a) proximal and (b) distal views of cut marked large bovid tibiae (MNE = 4). Cut marks produced by disarticulation are depicted.
Figure 4.196. (a) medial, (b) anterior, (c) lateral and (d) posterior views of cut marked large bovid tibiae (MNE = 2). Marks produced by sawing are depicted.
Figure 4.197. Anterior view of cut marked large bovid patellae (MNE = 18). Cut marks produced by all butchery activities are depicted.
Figure 4.198. Anterior view of cut marked large bovid patellae (MNE = 18). Cut marks produced by filleting and disarticulation are depicted.
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Figure 4.218. (a) medial, (b) lateral and (c) proximal views of cut marked small bovid middle and rear ribs (MNE = 54). Cut marks produced by filleting are depicted.
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Figure 4.226. (a) medial, (b) lateral and (c) proximal views of cut marked large bovid front ribs (MNE = 2). Cut marks produced by either filleting, evisceration, and/or disarticulating ribs are depicted.
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Figure 4.230. (a) medial, (b) lateral and (c) proximal views of cut marked large bovid front ribs (MNE = 2). Cut marks produced by filleting and/or disarticulating ribs are depicted.
Figure 4.231. (a) medial, (b) lateral and (c) proximal views of cut marked large bovid middle and rear ribs (MNE = 30). Cut marks produced by filleting and/or disarticulating ribs are depicted.
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