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The Taphonomy of Cannibalism: A Review of Anthropogenic Bone Modification in the American Southwest

SHARON A. HURLBUT*
Department of Anthropology, Arizona State University, Tempe, AZ, USA

ABSTRACT Mass deposits of altered human bone have been found at more than 30 sites in the American Southwest affiliated with the Chaco Anasazi culture. Anasazi bone deposits include individuals of all ages and both sexes, sometimes left lying unburied on kiva or habitation room floors, and are rarely encountered in formal cemeteries. Human remains in these deposits are characterized by marked fragmentation and disarticulation, cut marks, percussion fracture, burning, and end-polishing of bone fragments. A close resemblance to faunal remains from trash middens at Anasazi sites has led to an inference of cannibalism.

The taphonomic signature of cannibalism identified from these deposits is compared with other forms of cultural alteration of human bone. Bone modifications associated with mortuary practices, warfare, mutilation, human sacrifice, and execution are reviewed using examples from around the world. Identical types of modification are linked with a variety of behaviours, but distinct combinations of taphonomic patterns differentiate between cannibalism, violence, and other cultural practices. The numbers of individuals involved, age and sex composition, and burial contexts also differ. Intentional, extensive fragmentation, scattering of disarticulated elements, loss of vertebrae, and pot polish are taphonomic characteristics which combine to set Anasazi human bone deposits apart from documented cases of warfare or interpersonal violence.

Key words: taphonomy; cannibalism; violence; bone modification; Anasazi

Introduction

During the past two decades, a uniform set of taphonomic modifications has been identified from scattered, broken, cut, and burned human remains at numerous Anasazi sites in the Four Corners region of the American Southwest (where Arizona, New Mexico, Utah, and Colorado meet (Figure 1)). All but one of these sites are associated with, or are near, sites within the Chaco Phenomenon. The Anasazi culture developed in the San Juan Basin during the late Basketmaker and Puebloan periods (AD 400–1350). Chacoan Anasazi sites are characterized by large, multi-story masonry pueblos, the presence of ritual structures (great kivas), ceramic artifacts, a system of well-designed roads, water control features, and reliance on agriculture (Vivian, 1990; Cordell, 1997). The typical Anasazi burial pattern involved flexed or extended inhumations interred in refuse middens or the fill of abandoned rooms (Stanislawski, 1963; Akins, 1986), but the assemblages of modified bones have been interpreted by various researchers as evidence of cannibalism (Flinn *et al.*, 1976; Luebben & Nickens, 1982; Nass & Bellantoni, 1982; Turner, 1983, 1988, 1989, 1993; Malville, 1989; Baker, 1990; Turner & Turner, 1990, 1992a, 1995, 1999; White, 1992; Dice, 1993; Minturn, 1994), interpersonal violence and warfare (Bullock, 1991, 1992), or ritual execution of witches (Darling, 1999; Ogilvie & Hilton, 2000). Previously undocumented Anasazi mortuary practices have also been suggested as a possible explanation (Bahn, 1991, 1992; Ogilvie & Hilton, 1993). Contextual information for many of the assemblages is limited due to early

* Correspondence to: 3134 E. McKellips Rd., #185, Mesa, AZ 85213, USA. E-mail: drossicle@aol.com

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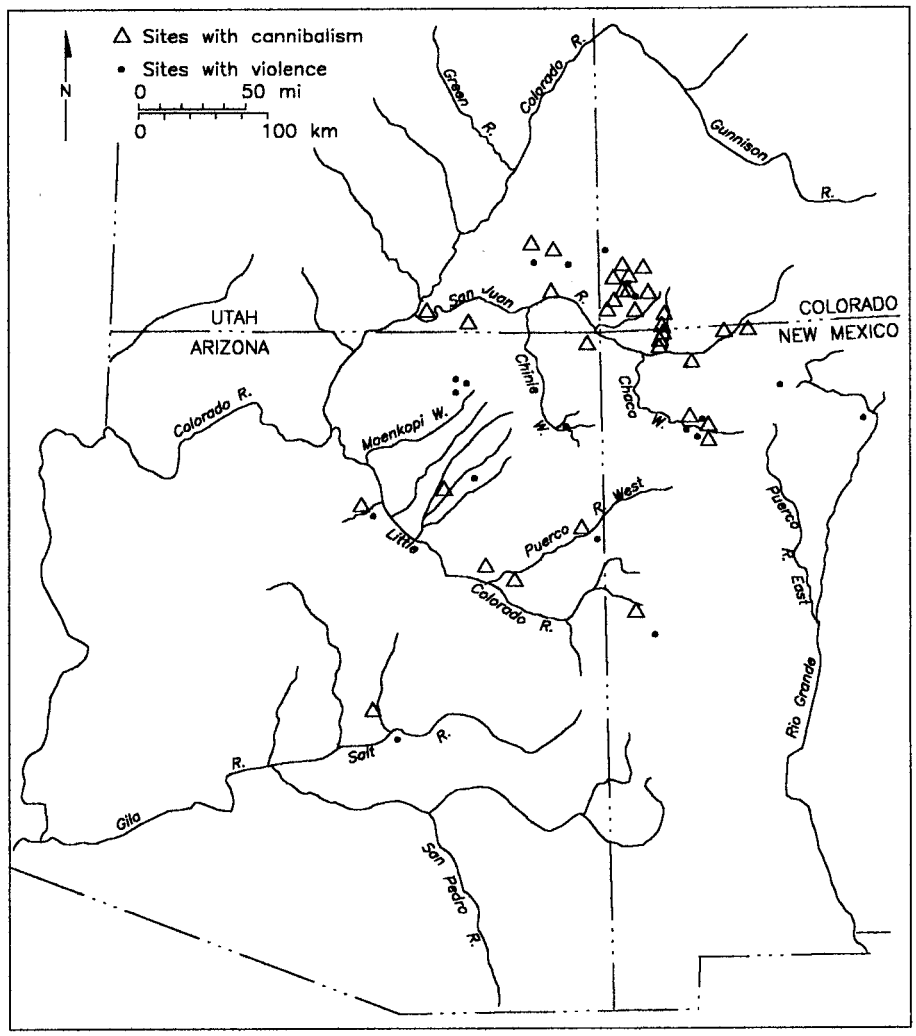

Figure 1. Southwest sites with cannibalism and violence. After Turner & Turner (1999).

excavation practices and a lack of published reports. Studies therefore tend to focus primarily on osteological and taphonomic analysis of the skeletal remains themselves.

In 1940, Efremov (1940) defined taphonomy as the study of the processes which affect bone from death through to burial and fossilization. Efremov realized the fossil record contains biases and sampling errors which have distorted and obscured the information that can be recovered from a fossil assemblage. Archaeologists have applied taphonomy primarily to identify processes which alter animal bone assemblages in order to reconstruct their original composition, condition, and utilization. An increasing focus on bioarchaeological analysis, forensic casework, and the rapid reburial of prehistoric remains in North America are resulting in greater numbers of studies employing taphonomic analysis of human remains.

This review will compare and discuss anthropogenic taphonomic patterns in Anasazi assemblages and the cultural behaviours interpreted from them. Although bone modifications produced by natural agents may mimic those produced by humans, most researchers agree these

agents can be distinguished by careful consideration of the combinations and patterning of modifications. No one has yet suggested that the Anasazi assemblages at the centre of the debate were the result of natural processes alone, and human activity is always seen as responsible for their formation. The types of bone modification associated with a number of behaviours, including cannibalism, mortuary practices, autopsy, violence, sacrifice, and ritual artifact production, are outlined. Behavioural interpretations are based on multiple lines of evidence whenever possible, including taphonomy, demography, context, ethnohistorical accounts, and analogy.

Taphonomic signature of cannibalism

Although researchers in the American Southwest speculated on the possible occurrence of cannibalism as early as 1902 (Hough, 1902), only since the 1980s has the phenomenon of cannibalism been systematically investigated. Turner (1983) examined human remains from ten mass bone deposits across the Four Corners area of Arizona, New Mexico, Utah, and Colorado. Taphonomic comparison of these deposits revealed a shared pattern of bone modification by human action, indicated by the presence of cut marks, percussion breakage, and burning. In general, these assemblages seemed to reflect short-term depositional episodes and were marked by good bone preservation, disarticulation and loss of elements, an extremely high degree of fragmentation, cut marks indicative of butchering and skinning, traces of burning, and a low frequency of marks suggesting gnawing or breakage by nonhuman animals. Both adult males and females were often represented, as well as children, infants, and even late-term foetuses. The number of individuals ranged from one to 35 and most assemblages included at least five individuals.

A minimal set of six taphonomic criteria for identifying cannibalism has been proposed by a number of authors: perimortem breakage, anvil abrasions, cut marks, burning, underrepresentation of vertebrae, and pot polish (White, 1992; Turner & Turner, 1999). Interpretation of these characteristics as evidence of cannibalism is based on similarity with faunal remains inferred to be food refuse. Similar criteria have been used to infer cannibalism in assemblages from other parts of the world (Villa, 1992; Villa *et al.*, 1986a,b, 1987, 1988; Pijoan & Mansilla, 1990; Pijoan Aguadé & Lory, 1997; Antón & Steadman, 1998; DeGusta, 1998).

Perimortem fracture

The most striking feature of the Anasazi assemblages interpreted as cannibalized is the extreme degree of fragmentation. Turner & Turner (1999) reported frequencies of breakage ranging from 3.9 to 100% in such assemblages and many showed greater than 75% breakage. Crania and postcranial remains were extensively broken into small pieces and long bones were often processed to a relatively uniform size (White, 1992; Turner & Turner, 1999).

It is suggested that this fragmentation is perimortem, that is, it occurred at or around the time of death. Some of the fractures are indicative of violence: depressed skull fractures, tooth evulsion, and mutilation to the face all suggest that individuals were struck repeatedly on the head (Flinn *et al.*, 1976; Baker, 1990; Turner & Turner, 1990, 1992a; Dice, 1993; Turner, 1993). On their own, such injuries might be interpreted as evidence of warfare or interpersonal conflict (Turner *et al.*, 1993). Most of the fragmentation in these assemblages, however, is due to percussion breakage caused by striking a bone set against an anvil with a hammerstone.

Perimortem breakage of long bones is indicated by spiral fracturing, which is characteristic of mechanical failure in fresh bone (Johnson, 1985). As pointed out by Johnson (1985), tensile failure along a helical path in fresh long bones can be caused by either static or dynamic loading, so the spiral pattern alone provides no evidence as to agency. However, other fracture features and bone surface marks are useful for determining the agents responsible. Fractures resulting from percussive force are associated with impact notches (flake scars), crushing,

adhering flakes of bone, and abrasions. Perimortem breakage of skulls results in depressed fractures as well as bevelling and spalling of the interior surface (Ubelaker & Adams, 1995; Crist *et al.*, 1997; Frayer, 1997). Another distinguishing feature of breaks which occurred around the time of death is that the fracture surfaces are typically identical in colour with surrounding bone surfaces (Ubelaker & Adams, 1995).

Dynamic loading of dry bones produces breakage along split line features, resulting in transverse fractures perpendicular to the bone surface (Johnson, 1985). Post-mortem breaks can be identified by the presence of linear or stepped fractures and fracture edges which appear rough. Villa & Mahieu (1991) observed that post-mortem fractures which occur as a result of sediment compaction are recognized by the presence of incomplete breaks and the close spatial association of fragments from a single bone. Later post-mortem fractures that occur during excavation exhibit clean, white fracture surfaces which contrast with stained and darkened external bone surfaces (Villa & Mahieu, 1991; Ubelaker & Adams, 1995; Crist *et al.*, 1997).

Although carnivores cause spiral fracturing and produce notches similar to those created by percussion breakage, Capaldo & Blumenschine (1994) have identified several characteristics which differentiate tooth and percussion notches. Carnivores break bone by static loading between their upper and lower jaws, much like pressure flaking of stone tools. In contrast, humans use hammerstones to produce breakage by dynamic loading, which is similar to hard-hammer flaking and Capaldo & Blumenschine (1994) found that percussion notches occurred more frequently than those produced by carnivore teeth. In addition, percussion notches occurred at an obtuse angle and were morphologically broader and shallower than tooth notches, which were also more perpendicular (Capaldo & Blumenschine, 1994).

Percussion abrasions

Anvil abrasions (or percussion striae) are striations that result from the movement of stone against bone during percussion breakage. Such abrasions have been identified on both cranial and postcranial elements with perimortem fracture and they appear as sets of fine parallel scratches on the surface of bones. In contrast to cut marks, they are shallow and may be curved as well as straight.

Blumenschine & Selvaggio (1988) suggested that abrasions and other percussion marks are diagnostic of human activity. However, as White (1992) pointed out, abrasions alone are microscopically indistinguishable from trampling marks. It is the *association* of percussion abrasions with flake scars that is considered diagnostic of human bone fracturing, particularly when concentrated in areas of marrow exposure (Turner, 1983; Blumenschine & Selvaggio, 1988; White, 1992). Such striations are not associated with the carnivore tooth notches described by Capaldo & Blumenschine (1994).

Cut marks

Cut marks are produced by the action of sharp-edged tools against a bone surface. Stone tool cut marks are identified through scanning electron microscopy by a V-shaped cross-section, multiple striations running parallel within the main groove, shoulder effect, and bifurcated or split terminations (Allen *et al.*, 1985; Eickhoff & Herrmann, 1985; During & Nilsson, 1991; Lyman, 1994; Bueschgen & Case, 1996). Slicing and scraping cut marks are generally longer than chopping cut marks (Owsley *et al.*, 1994) and may appear U-shaped in cross-section (Raemsch, 1993). It is important to note that nonhuman agencies may produce cut mark mimics which are indistinguishable from stone tool cut marks, even under magnification (Shipman & Rose, 1984; Andrews & Cook, 1985; Lyman, 1987; Fiorillo, 1989; Oliver, 1989).

In addition to the morphology of cut marks, their distribution provides another line of evidence indicating human activity. The concentration, direction, and repetitive patterning of cut marks at apparently planned locations on elements is a good indication that real cut marks rather than mimics are represented (Lyman, 1987). Butchery, dismemberment, defleshing,

and other forms of carcass processing result in different patterns of cut marks, chop marks, anvil abrasions, and fracturing. Disarticulation cut marks are concentrated on articular surfaces (Shipman, 1980; Binford, 1981; White, 1992; Dice, 1993; Olsen & Shipman, 1994), while randomly distributed short cut marks or broad areas of scraping are considered indicative of defleshing (Feagins, 1989; Raemsch, 1993; Olsen & Shipman, 1994).

Human remains identified as probably cannibalized exhibit cut marks on postcranial as well as cranial elements. Cut marks on skulls in these assemblages are often indicative of scalping, with long cuts encircling the crown (Flinn *et al.*, 1976; Malville, 1989; White, 1992; Minturn, 1994; Turner & Turner, 1999), whereas long bones show cut marks in areas associated with removal of muscle tissue and disarticulation (Nass & Bellantoni, 1982; Turner, 1983; White, 1992; Turner & Turner, 1995). In many instances, cutting clearly took place prior to percussion breakage, as demonstrated by the presence of cut marks crossing fracture lines (Turner & Turner, 1995) and by the observation that '. . . anvil and hammerstone abrasions cannot occur on bones thick with overlying muscle bundles, such as the femur, inner aspects of the lower leg, upper arm, and vertebral bodies, until the respective overlying tissue has been stripped or cut away' (Turner & Turner, 1992b).

Burning

Burning in assemblages interpreted as cannibalized is extremely variable, ranging from less than 1% to almost half of all bones or bone fragments. Burning is the most problematic characteristic of the cannibalism signature since bone subjected to very minimal heating is extremely difficult to recognize and, if it could be more easily identified, the number of cases of probable cannibalism would presumably be even greater (Turner & Turner, 1999).

Changes in colour and surface texture provide clear evidence of burning in bone. Burned bone warps and fractures, exhibiting a pattern of cracking in a checked pattern on the surface and exfoliation of the outer portion of the cortex (Fink, 1996). Bone surfaces also undergo colour changes directly associated with specific temperature ranges (Shipman *et al.*, 1984). Less obvious are changes to the organic component of bone, which may occur during low-level heating that does not produce surface alteration. Scanning electron microscopy reveals histological changes in bone exposed to minimal heating or burning, allowing differentiation of burned and unburned bone (Fink, 1996).

In the Anasazi assemblages interpreted as cannibalized, the degree of burning often varies both between and within elements. Differential burning of fragments from the same element show that the bone was broken first and then burned (Turner & Turner, 1992a; White, 1992). This pattern provides additional evidence that fracturing was perimortem. Mancos Canyon crania showed a pattern of burning consistent with placement of the entire head in the fire, followed by percussion breakage apparently aimed at removal of the brain (White, 1992). For most such assemblages, however, it appears that the scalps were first removed, followed by percussion breakage to expose head contents, with burning as the final step in the process (Turner & Turner, 1999). Both heads and other body parts appear to have been roasted, as indicated by charring of portions with little overlying soft tissue, such as the elbow (Flinn *et al.*, 1976; Nass & Bellantoni, 1982; Turner, 1993). Based on the presence of burning concentrated on the top of a skull from Burnt Mesa, Flinn *et al.* (1976) remarked: 'Perhaps the skull itself was used as a cooking utensil, being turned upside down so that it rested in the fire pit on the frontal and parietal sections, while the brain roasted within it'.

Pot polish

White (1992) first identified pot polish, which consists of bevelled abrasions and polishing of the tips of long bone shaft fragments, in his detailed analysis of the Mancos Canyon human remains. Polishing is observable only under

magnification, when the bone surface appears shiny and ivory-like. After recognizing this modification, White examined human remains from the Yellow Jacket 5MT-3 site and artiodactyl remains from Badger House at Mesa Verde (White, 1992). The presence of polishing in all three assemblages led him to postulate that it was caused when the tips of bone fragments rubbed against the abrasive surface of a cooking pot. An experiment using splintered mule deer metapodials boiled and stirred in a corrugated ceramic vessel resulted in replication of the polishing modification (White, 1992).

According to Turner & Turner (1999), however, 'Polishing may also occur with transporting, laboratory cleaning, storage in plastic bags, and other sorts of postexcavation handling. . . '. They suggested that such forms of polish '. . . can probably be recognized by the presence of polishing on the sides as well as the ends of bone fragments' (Turner & Turner, 1999).

End-polishing, in conjunction with percussion breakage, anvil abrasions, and thermal alteration, has become a powerful diagnostic tool for identifying human action. Pot polish limited to the ends of bone fragments also provides possible evidence that cooking took place. Based on element representation, percussion breakage, and pot polish in the Mancos assemblage, White (1992) suggested that the human remains were crushed and boiled for grease extraction.

Missing vertebrae

The final taphonomic criterion for suggesting an assemblage of human bone has been cannibalized is the under-representation of vertebral elements. Vertebrae occur with considerably less than half the expected frequency in these assemblages. Turner (1983) noted a deficiency of vertebrae in his 1983 comparison of mass burials from the Southwest but was unable to explain it. The identification of vertebral fragments with percussion abrasions and crushing from Canyon Butte Ruin 3 and other sites provided an explanatory mechanism: vertebrae appear to have been systematically smashed and boiled for grease extraction along with long bones (Turner & Turner, 1992a, 1995).

Analogy with butchering

In 1920, George Pepper (1920) based his inference of cannibalism at Peñasco Blanco on similarities between modified human bone and faunal remains representing food refuse. Both types of bone appeared to have been intentionally broken open for marrow extraction. More recent taphonomic studies have provided further detailed evidence of the similarities between modified human remains and butchered animal carcasses.

Lyman (1987) provided an excellent review of the development of butchery pattern studies, observing that much of butchery research is based on the concept of purposiveness. Purposiveness criteria attempt to explain patterns of butchering marks on the basis of anatomical reasons for their placement. Lyman (1987) pointed out: 'The "anatomical" reason relates to a human perception of how to process or butcher an animal carcass into humanly consumable portions'. Cut marks clustered near joint surfaces are indicative of carcass dismemberment, while cut marks at muscle attachments reflect removal of meat and defleshing.

Anasazi butchering and food processing

White (1992) and Dice (1993) systematically analysed nonhuman animal remains from Anasazi sites using the same taphonomic methods applied to human bone, in order to compare the signature of animal butchering with that of hypothesized cannibalism. Dice (1993) observed similarities in antelope remains from Wupatki Pueblo and human remains from Leroux Wash. Cut marks at joints and anvil abrasions on long bone shafts occurred with the same placement and frequency on both sets of remains.

White (1992) reported that modifications interpreted as cannibalism were qualitatively similar to those observed worldwide in zooarchaeological

assemblages, and were quantitatively identical to butchered faunal remains from Anasazi sites. Both the human and animal bone assemblages studied by White exhibited modifications consistent with defleshing, disarticulation, breakage, and cooking. He concluded: 'It is the patterned bone destruction and postpercussion processing that constitute the best evidence warranting the inference that bone tissue was being manipulated to obtain nutrition' (White, 1992).

Likewise, Turner and Turner found the same types and amounts of processing among humans, small mammals, and antelope from archaeological sites in the American Southwest. They remarked '. . . if it were not possible to distinguish human bones from those of large animals in archaeological deposits, cannibalism would not be an issue, because the perimortem processing for the two is qualitatively and quantitatively similar. All bone in archaeological refuse would simply be identified as the residue of meals' (Turner & Turner, 1999).

Old World butchery

For many archaeologists, the most convincing evidence of cannibalism has been reported from the prehistoric record of France by Villa *et al.* (1986a,b, 1988)(Villa, 1992). At the Neolithic cave site of Fontbrégoua, individual butchery episodes were represented in clusters of animal bone which exhibited defleshing and dismemberment cut marks and percussion breakage of long bones (Villa *et al.*, 1986a). Three of the clusters also contained human remains showing distribution and frequency of cut marks and marrow fracturing virtually identical to that in the nonhuman material (Villa *et al.*, 1988). In addition to identical patterns of modification, altered human bone was deposited in the same context as food refuse at this site, providing further support for an interpretation of cannibalism. Villa *et al.* (1988) forcefully pointed out, 'To argue that bodies were defleshed but that flesh was not eaten, one must believe that the Fontbrégoua people butchered but did not eat their meat animals and that they gave secondary burial to boars, badgers, deer and sheep. Clearly cannibalism is the only satisfactory explanation for the evidence found at Fontbrégoua'.

Inferring cannibalism

The clear similarities between butchered animal remains and the assemblages of modified human bones discussed here suggests they were processed in the same way for the same purpose, namely consumption. However, as several authors have noted, there is nothing worse than calling someone a cannibal, which perhaps explains why many researchers are reluctant to accept this interpretation (Arens, 1979; Bahn, 1991; Askenasy, 1994; Tannahill, 1996; Darling, 1999; Ogilvie & Hilton, 2000). Some have simply ignored the possibility of cannibalism, whereas others have rejected this interpretation and suggested alternatives.

Both White and Turner and Turner emphasized that their minimal criteria for inferring cannibalism are extremely stringent, to the extent that some instances of prehistoric cannibalism had undoubtedly been overlooked. Turner & Turner (1999) stated: '. . . our criteria for hypothesizing cannibalism are probably too rigorous, but given the extraordinarily controversial nature of the topic, we believe it is best to err on the side of conservatism'. White (1992) noted: 'The only higher level of inference would be that in which cannibalism was only to be inferred upon the recovery of human bones such as terminal phalanges from within demonstrably human coprolites'. This sort of evidence may well be forthcoming. A human coprolite associated with an assemblage of human remains interpreted as cannibalized from Cowboy Wash, Colorado, may have contained human proteins that could only have been derived by consumption (Dold, 1998; Preston, 1998).

Mortuary practices

Mortuary practices certainly affect preservation of different skeletal elements and may involve some modifications to bone, but most are not likely to result in completely disarticulated, scattered, and highly modified deposits of human

bone. Individuals interred as primary inhumations are usually articulated and accompanied by artifacts intentionally placed with the body. Intentional cremations typically include mortuary offerings and are characterized by heavy damage due to burning and fragmentation of the body, but do not include cut marks, percussion breakage and abrasions, and pot polish. Mummified corpses, even when intentionally modified by breakage, defleshing, and exposure to heat, are complete and articulated. Secondary burial, however, often includes intentional disarticulation and defleshing of remains which could potentially resemble the patterns interpreted as cannibalism.

Secondary burial

Individuals may be temporarily interred or exposed before placement in a final deposit. Secondary burials are found in many contexts: mass graves or ossuaries, individual graves, urns or other containers, or bundle burials. In North America, historic accounts describe secondary burial practices such as the periodic Huron Feast of the Dead ceremony, in which the remains of those who had died since the previous ceremony were gathered and buried together in a large ossuary (Ubelaker, 1989). The protohistoric period in west-central Alabama was characterized by secondary burial in bundles as well as urns, with partial remains of multiple adult individuals often found in a single urn (Hill, 1996).

Several Northern Plains groups practised exposure of the body on scaffolding prior to burial (Snortland, 1994), and the Choctaw intentionally defleshed corpses (Ubelaker, 1989). In South Africa, the use of human remains in rain-making rituals included sacrifice, stripping of flesh from the bones, and placement in a large ceramic vessel (Klapwijk, 1989). Human remains from the Riviere aux Vase site in Michigan were processed and buried in bundles containing only a skull and long bones (Raemsch, 1993). Similarly, remains found near Prescott, Arizona, were placed in well-defined, neat bundles consisting of long bones aligned along an axis and distributed evenly on either side of the skull (Smith *et al.*, 1977). Additional secondary burials reported from the American Southwest due to cultural practices or reburial following disturbance exhibited the same pattern (Vickrey, 1939; Grant, 1989; Atwell & Menkhus, 1991; Hurlbut & Murphy, 1998).

Preservation in secondary burials

Secondary burial results in partial or complete disarticulation, either through intentional dismemberment or decomposition. Smaller elements such as phalanges are often lost due to incomplete recovery (Smith *et al.*, 1977; Grant, 1989; Ubelaker, 1989; Irish *et al.*, 1993). Moche skeletons recovered from burial tombs at the site of San José de Moro, Perú, exhibited varying degrees of disarticulation and bone migration (Nelson, 1998). Some body segments remained articulated, while other portions were disarticulated and scattered within the burial, indicating at least partial retention of soft tissue. Bones of the thorax, forearm, and hands experienced the most movement, while legs were most likely to retain their position. Nelson (1998) suggested that this pattern reflected an extended mortuary ritual in which exposed bodies had time to decompose partially and become mummified prior to their final interment. Disarticulation and bone movement occurred as a result of the insertion of brittle bodies into the tombs through vertical shafts (Nelson, 1998).

Also associated with secondary burial are weathering due to exposure (Olsen & Shipman, 1994; Snortland, 1994) and carnivore gnawing (Smith *et al.*, 1977; Turner & Turner, 1990; Irish *et al.*, 1993). Differential weathering of bones both before and after defleshing in Northern Plains Indian skeletons indicates that open-air exposure and cleaning occurred over an extended period (Olsen & Shipman, 1994). Likewise, the presence of lichen markings on bones recovered in the Copper Basin of Arizona indicate exposure prior to burial (Smith *et al.*, 1977). Unprotected corpses inevitably attract carnivores, who chew on and transport skeletal elements and these marks are also evident in secondary burial assemblages (Haglund, 1997; Turner & Turner, 1999).

Body preparation

Secondary burial often involves intentional defleshing and dismemberment, resulting in alteration of bone surfaces. Defleshing cut marks consist of slicing and scraping marks located randomly on long bone shafts (Russell, 1987; Raemsch, 1993) and scattered over all parts of the skull (Villa *et al.*, 1986a; White, 1986; Feagins, 1989; Olsen & Shipman, 1994; Owsley *et al.*, 1994; Torbenson *et al.*, 1996; Massey & Steele, 1997). Olsen & Shipman (1994) pointed out that, although cranial defleshing and scalping marks are very similar, the former are found on the face and basicranium as well as the vault. They also noted: 'Multiple short, straight marks around the orbit margins and nasal aperture and on the canine eminences are not uncommon in secondary burials. The abundance of cutmarks indicates that removing the flesh of the nose, around the orbits, and along the jaw was often difficult' (Olsen & Shipman, 1994).

Cut marks indicative of disarticulation occur on or near articular surfaces in areas of muscle attachment (Torbenson *et al.*, 1992; Raemsch, 1993; Olsen & Shipman, 1994). Raemsch (1993) examined the skeletal remains of approximately 300 individuals from the Riviere aux Vase site in southeastern Michigan which were interred in secondary bundles consisting of long bones and a skull. She reported that long U-shaped cut marks with flat bottoms and linear indentations were found primarily on the shafts of long bones, while short, V-shaped cut marks occurred in articular areas. These morphological differences were interpreted as the result of defleshing (U-shaped) and dismemberment (V-shaped) activities (Raemsch, 1993). Raemsch compared this pattern to that associated with perimortem violence and cannibalism, noting: 'Although the *Riviere aux Vase* skeletons show modifications similar to those associated with perimortem violence, the locations and frequencies of the modifications differ, suggesting they most likely result from other behaviors. Specifically, cuts are not found in the specific areas affected by a butchering process; there is no evidence of hammerstone or anvil use on the skeletons; bones show fragmentation of different forms (those that commonly result from in situ crushing, transport, excavation, etc.); and few skeletons show evidence of charring (only 1% of the skeletons are charred, none of which are affected on more than one bone)'.

Post-mortem study

Another possibility is that bodies may have been examined to determine the cause of death or learn more about disease or trauma. Based on ethnographic evidence, Allen *et al.* (1985) suggested that scalping at Grasshopper Ruin and Nuvakwetaqa in Arizona may have been related to autopsy. Ethnographic accounts related that members of the Hopi Mausuwu society were credited with the ability to cure headaches and heal 'head swellings'. Three crania with scalping marks from these sites had depressed fractures, suggesting that scalping may have been performed to permit inspection of the skull in order to understand such trauma better (Allen *et al.*, 1985).

In the historic period, saw cuts suggest that the tops of skulls from Sens, France, were intentionally removed for study of the brain (Valentin & d'Errico, 1995). Similarly, cut marks on skeletal remains from the Newcastle Infirmary Burial Ground in England revealed evidence of numerous post-mortem procedures, including craniotomies and tibial prosection (Start & Robertson, 1998). While post-mortem examination of the human body can clearly result in cut marks, they have their own characteristics and other modifications, including percussion fracture, pot polish, and burning, are not associated with such procedures.

Violence

Interpersonal violence and warfare in the archaeological record are indirectly indicated by the presence of fortified sites in defensive locations, site destruction and abandonment, preserved weapons and armour, and iconography depicting warfare (Haas & Creamer, 1993; Ferguson, 1997; Larsen, 1997; Martin *et al.*, 1997; Maschner, 1997; LeBlanc, 1999). Direct

evidence of violence, however, can be observed only in human remains. The most obvious indicators are weapons embedded in bone, perimortem injuries, and evidence of mutilation. Because a high degree of perimortem fracturing is associated with some cannibalized assemblages, it is important to discriminate evidence of violence alone from modifications which are related to body processing. The archaeological context of skeletal remains, mortuary treatment (or lack thereof), demography, associated artifacts, and ethnohistoric accounts provide further evidence to support interpretations of violent behaviour.

Perimortem damage produced by sharp weapons

Specific weapons can be identified by the marks they produce (Merbs, 1989). Stone-bladed weapons such as knives and projectile points produce cut marks when they strike bone. Ribs are most frequently affected in association with violence due to repeated stabbing in the chest and thorax (Owsley *et al.*, 1977; Smith, 1993; Bovee & Owsley, 1994; Olsen & Shipman, 1994; Lambert, 1997). These marks are V-shaped and occur as single, isolated marks or sets of marks distributed widely throughout the ribcage. In addition, weapon tips may break off and become embedded in bone or within the body cavity (Wilson, 1901; Merbs, 1989; Hurst & Turner, 1993; Smith, 1993; Turner *et al.*, 1993; Brooks, 1994; Hollimon & Owsley, 1994; Bueschgen & Case, 1996).

Piercing blows to the skull by sharp-bladed stone weapons such as axes produce oval or elongated depressed fractures, sometimes V-shaped in cross-section, with well-defined straight edges or indentations (Saul & Saul, 1989; Willey, 1990; Milner *et al.*, 1991; Turner *et al.*, 1993; Bridges, 1996; Frayer, 1997; Jurmain & Bellifemine, 1997; Lambert, 1997). Milner *et al.* (1991) reported depressed cranial fractures in individuals recovered from an Oneota cemetery with an elongated outline and slightly curved margins consistent with the shape of groundstone celts. Likewise, a circular perforation of the left maxilla on a Basketmaker adult male from Cave 7 closely matched large bone daggers recovered from the site (Hurst & Turner, 1993). Star maces used in prehistoric Peru also produced distinctive patterns consisting of circular depressions and perforations on crania (Merbs, 1989).

Sharp-edged metal weapons (e.g. swords, knives, hatchets) also produce punctures with well-delineated sharp borders (Anderson, 1996), as well as linear slashing marks (Snow & Fitzpatrick, 1989; Gill, 1994; Melbye & Fairgreave, 1994; Hutchinson, 1996; Liston & Baker, 1996) and deep, V-shaped cuts with wedges of bone removed (Shackley, 1986; Blakely & Mathews, 1990). Bones may be cut in half, partially severed, or have portions shaved away (Merbs, 1989; Hutchinson, 1996; Hodges, 1997). A square perforation in the left parietal of a young adult male from a Gallo-Roman site in France matched with the squared facets of spears used throughout the region during this period (Billard, 1991).

Postcranial remains from the 16th century Tatham Mound site in Florida showed evidence of blows using sharp-edged metal weapons (Hutchinson, 1996). Damage occurred perpendicular or oblique to the long axis of the bones; the acromion was sliced from a right scapula, and a left humerus was severed almost in half. Although it was unclear whether Spaniards or other Native Americans inflicted the wounds, Hutchinson (1996) pointed out that they were consistent with slashing blows by metal weapons such as swords, implying some contact between the two groups.

Perimortem fracture

Bludgeoning of the skull with blunt weapons (e.g. clubs) results in roughly circular depressed fractures without clearly defined edges, extensive comminuted fractures, bevelling and internal vault release, and cracks radiating outward from the point of impact (Owsley *et al.*, 1977; Walker, 1981; Merbs, 1989; Snow & Fitzpatrick, 1989; Milner *et al.*, 1991; White, 1992; Hurst & Turner, 1993; Olsen & Shipman, 1994; Jurmain & Bellifemine, 1997; Robb, 1997; Wilkinson, 1997). Depressed fractures resulting only from violent blunt-force blows to the head would

exhibit the same characteristics as perimortem trauma associated with cannibalism, but would not include the presence of anvil abrasions as the bone surface would not be directly exposed (Turner, 1993; Turner *et al.*, 1993). Additionally, perimortem fracture associated with blunt weapon violence tends to be concentrated on the skull, with little damage to postcranial elements (Hurst & Turner, 1993).

Patterning of perimortem damage

The distribution of perimortem damage on skeletal remains also provides information about patterns of violence in the past. Fractures of the ulna shaft and dislocation of the radius head (parry fractures) are often associated with warding off blows to the head by raising the forearm (Merbs, 1989; Smith, 1993). Likewise, fractures to the outer bones of the hand reflect a defensive posture (Cybulski, 1990).

Lambert (1997) noted that males from prehistoric southern California exhibited a concentration of cranial fractures on the left frontal, suggesting they were the result of face-to-face fighting among right-handed individuals. Individuals recovered from the late Mesolithic site of Ofnet in Bavaria, on the other hand, exhibited perimortem damage over the entire cranial vault, although almost two-thirds of wounds occurred on the right side (Frayer, 1997). Although Frayer provided no interpretation of why perimortem wounds might be concentrated on the right side of the skull, evidence for a large-scale massacre at Ofnet, including the high proportion of females and children, suggested that the inhabitants may have been caught off guard and bludgeoned from behind as they tried to escape their assailants.

A pattern of cuts and punctures on the anterior surfaces of postcranial elements, primarily the left legs, has been observed on skeletons of warriors from the Battle of Visby in 14th century Sweden (Blakely & Mathews, 1990; Larsen, 1997). Such wounds are indicative of hand-to-hand combat in which the upper body was well protected by armour and blows were dealt by right-handed individuals (Merbs, 1989). An almost identical pattern was observed by Blakely & Mathews (1990) at the 16th century King site in Georgia, as a result of a confrontation between Native Americans and the soldiers of Hernando de Soto's expedition in 1540.

The Visby remains also showed damage concentrated on the left side of the skull, again indicating hand-to-hand combat by right-handed individuals, as well as to the back of the skulls, suggesting some individuals were struck from behind while running away (Larsen, 1997). In contrast, skeletons from a 14th century battle at Zaimokuza, Japan exhibited a pattern of sword cuts located almost exclusively on the frontal and parietals, with no wounds to the occipital (Shackley, 1986). This is consistent with strict 13th century battle rules dictating face-to-face combat with no retreat (Shackley, 1986).

Demography

Kennedy (1994) pointed out that violent trauma is not always identifiable on skeletal remains and emphasized the need to examine other aspects of assemblages, including demography and context. Males tend to be associated more frequently with warfare-related trauma than females and children, reflecting not only greater involvement of males in fighting, but also the capture of women and children (Willey, 1990; Hurst & Turner, 1993; Smith, 1993; Olsen & Shipman, 1994; Bridges, 1996; Jurmain & Bellifemine, 1997; Larsen, 1997; Maschner, 1997). Inhabitants of the Larson Village Site in South Dakota were killed and their village destroyed. Compared with the age and sex distribution of formal burials in the village cemetery, the unburied remains associated with this massacre were characterized by a high proportion of males and a low proportion of females and children, suggesting women and children were captured by the attackers (Owsley *et al.*, 1977). A similar massacre and destruction was documented for Crow Creek, South Dakota, where women also appeared to have been taken captive, as indicated by low representation of adult females in the assemblage (Willey, 1990).

The high prevalence of both healed and perimortem cranial trauma among males compared

to females in early Italy is seen as evidence of interpersonal violence due to culturally defined aggressive behaviour for males (Robb, 1997). In contrast, the individuals killed by de Soto's forces at the King site included a high proportion of young adult women and older individuals of both sexes concentrated in two clusters within the low-ranking portion of the site, suggesting that only members of particular lineages were involved in the fighting (Blakely & Mathews, 1990).

While males are often the victims of warfare, females and children are likely to be victims of small-scale raiding parties or individual attacks (Milner *et al.*, 1991; Hollimon & Owsley, 1994; Bridges, 1996; Bueschgen & Case, 1996). At the Heerwald site in west-central Oklahoma, the remains of an adult female, a near-term foetus, and a child were recovered from a single pit (Bovee & Owsley, 1994). Perimortem trauma and scalping cut marks showed that the woman had suffered a violent death. Certain forms of violence may be directed specifically at females (Lambert, 1997). McCarthy & Perlin (1997) reported a correlation between sex and the location of cranial trauma among individuals from Hasanlu, Iran. Males in this sample exhibited a higher frequency of trauma to the cranial vault, particularly the left frontal, while female injuries concentrated on the face, suggesting different patterns of violence (McCarthy & Perlin, 1997).

Context

Individuals killed in large-scale warfare are typically buried in mass graves (Hurst & Turner, 1993; Willey, 1990; Bridges, 1996; Liston & Baker, 1996) or left unburied where they fell (Owsley *et al.*, 1977; Ravesloot & Spoerl, 1989; Rohn, 1989; Hollimon & Owsley, 1994; Melbye & Fairgreave, 1994; Turner *et al.*, 1994). As Kennedy (1994) pointed out, massacre victims are often dumped unceremoniously into large pits away from settlements. Victims of single raids or small-scale violent episodes, on the other hand, are likely to be buried individually or in small groups (Bovee & Owsley, 1994; Bueschgen & Case, 1996; Bridges, 1996). At the Norris Farms # 36 cemetery in Illinois, adults of both sexes with perimortem injuries were recovered from graves containing up to five individuals (Milner *et al.*, 1991). These multiple burials were found within the cemetery and were clearly deposited at different times, leading Milner *et al.* (1991) to interpret them as victims of individual raids or small-scale fighting rather than a single large-scale battle.

Other taphonomic factors

Victims of violence recovered from burned structures display partial burning of skeletal elements, but not the complete incineration associated with intentional cremation (Willey, 1990; Hollimon & Owsley, 1994; Turner *et al.*, 1994). At the Larson site, massacre of the inhabitants was followed by burning of the village and skeletal remains exhibited charring on elements with little overlying tissue, and explosion of crania due to expansion of the brain during heating (Owsley *et al.*, 1977).

Raids usually occurred away from habitation sites and recovery of the victims' bodies may have taken several days. When time lapsed between violent episodes and burial of the victims, carnivores were attracted to corpses left lying on the ground (Owsley *et al.*, 1977; Willey, 1990; Turner *et al.*, 1994; Turner & Turner, 1999). Blakely & Mathews (1990) noted that only individuals with fatal wounds from the King site showed carnivore tooth marks, indicating a period of exposure between death and burial. Similarly, carnivore gnawing was observed on numerous individuals with perimortem trauma recovered from the Oneota cemetery at Norris Farms # 36 (Milner & Smith, 1989; Milner *et al.*, 1991). According to Milner & Smith (1989) the abdominal region and elements with little overlying soft tissue exhibited the highest frequencies of carnivore gnawing marks, while hands and feet were under-represented, probably due to destruction and/or transport by carnivores.

Victims of warfare and violence are therefore characterized by the presence of unhealed perimortem trauma, which may include blunt-force or sharp-object injury, fracture, and embedded weapons. Skeletons are at least partially

articulated, even when buried in mass graves following a large battle (Willey, 1990). Particular segments of the population are often represented, especially high frequencies of males and few subadults.

Mutilation and trophy taking

Mutilation/torture

Victims of violence often show evidence of mutilation in the skeleton. Intentional mutilation includes facial destruction and anterior tooth evulsion, characterized by blunt trauma and heavy fragmentation of the face (Owsley *et al.*, 1977; Patterson, 1977; Baker, 1990; Willey, 1990; Ogilvie & Hilton, 1993). Hurst & Turner (1993) observed massive perimortem damage to the faces of individuals recovered from Cave 7 and noted: 'Head damage. . . is brutally severe. Fracture patterns indicate that both clubs and hammer-like weapons were used to beat the victims. . .'. They suggested that such trauma may have been the consequence of torture.

Other forms of torture include application of burning pitch to the scalped area of the skull, suggested by scalping cut marks and circular patterns of scorching (Jamieson, 1983), and the cutting off of fingers (Lothrop, 1954). Human remains from the Saunaktuk site in the Canadian Arctic exhibited evidence of severe violence and mutilation. Femora with punctures through the distal ends may have represented the torture of two individuals corresponding to ethnohistorical accounts of piercing the knees and dragging victims through camp (Melbye & Fairgreave, 1994). At Fort William Henry, genital mutilation and disembowelment of British soldiers left behind after the massacre and surrender is indicated by the presence of numerous cut marks and damage to the pelvis and abdomen (Liston & Baker, 1996).

Skeletons recovered from the Pyramid of the Moon, a Moche site near Trujillo, Peru, exhibited trauma consistent with depictions of prisoner treatment in Moche art (Pringle, 1999). In scenes from a Moche warrior narrative, captured prisoners are struck in the nose to cause bleeding; several individuals from the Pyramid of the Moon had small, unhealed fractures of the nasal region. There was also evidence of torture, in the form of sticks or sharp objects which were pushed repeatedly into the feet of victims at this site (Pringle, 1999).

Trophy taking

Trophy body parts were often taken after battle as tokens of a warrior's bravery (Allen *et al.*, 1985; Seeman, 1988; Owsley, 1994), for ceremonial purposes (Zegwaard, 1959; Powell, 1977), or to provide protection from the dead enemy's spirit (Proulx, 1971; Owsley & Berryman, 1975). The most common form of trophy-taking was scalping, identified by a characteristic pattern of cut marks which encircle the crown of the head, usually beginning at the forehead, going over the ears, and across the back of the skull (Allen *et al.*, 1985; Smith, 1993; Olsen & Shipman, 1994). As discussed earlier, this pattern is clearly different from that of defleshing in which cut marks are distributed over all parts of the skull and face. Scalping has been identified on human remains from both prehistoric (Neumann, 1940; Allen *et al.*, 1985; Milner *et al.*, 1991; Bovee & Owsley, 1994; Bridges, 1996; Bueschgen & Case, 1996) and historic (Hamperl & Laughlin, 1959; Owsley *et al.*, 1977; Owsley, 1994) North American sites.

Heads were also taken as trophies, recognized by the presence of skulls not associated with postcranial remains (Hamperl & Laughlin, 1959; Owsley & Berryman, 1975; Powell, 1977; Robb, 1997; Maxwell, 1998), postcranial remains with no skull (Proulx, 1971; Merbs, 1989; Hollimon & Owsley, 1994) and cut marks on the base of the skull, mandible, and cervical vertebrae (Hamperl & Laughlin, 1959; Owsley *et al.*, 1977; Melbye & Fairgreave, 1994; Liston & Baker, 1996). Frayer (1997) described human remains recovered from the 'skull nests' at Ofnet, which consisted only of crania and cervical vertebrae with deep cut marks on the anterior surfaces. Massey & Steele (1997) reported on crania from a Maya skull pit in Belize, with cut marks which indicated that the heads were flayed and the flesh removed after decapitation.

Crania of sacrifice victims from Tlatelolco, Mexico, had perforated parietals and cut marks associated with their display on skull racks (*tzompantli*) (Pijoan *et al.*, 1989; Pijoan Aguadé & Lory, 1997). Trophy skulls from the Great Plains region of North America were characterized by holes drilled in the top or sides for attachment of a cord (Owsley *et al.*, 1994).

Hands, feet, and limbs were also occasionally taken as trophies (Owsley *et al.*, 1977; Hohmann *et al.*, 1985; Smith, 1993; Hollimon & Owsley, 1994; Olsen & Shipman, 1994; Smith, 1997). Smith (1993, 1997) identified forearm trophy-taking at Archaic sites in middle and western Tennessee, along with evidence of perimortem trauma and scalping. She carefully compared perimortem damage and cut marks interpreted as trophy-taking with mortuary practices, noting that dismemberment was not part of documented mortuary behaviour for this region. Smith stated: 'Dismemberment trophy taking of bones of the appendicular skeleton may be identified osteoarchaeologically in an undisturbed primary interment which exhibits circumferential cutmarks restricted to the area proximal to an absent limb. These cutmarks, if adjacent to the joint, may be accompanied by indications of perimortem snapping or splintering of the long-bone shaft. Any suggestion of defleshing such as numerous short stroke cutmarks or scraping over a broader surface area or cutmarks anywhere on the bone irrespective of kind or depth of the subcutaneous structure would undermine confidence in a warfare etiology for retrieval of particular bones' (Smith, 1997).

Execution and sacrifice

Many of the types of mutilation and perimortem damage described above also occur in association with more institutionalized forms of violence, such as execution and ritual sacrifice. Individuals can be executed or sacrificed in a number of different ways, including decapitation, hanging, and being struck fatal blows with any number of weapons. A pattern of greater burning on lower limbs and distal portions of limbs was observed on human remains recovered from the Roebuck site in western Ontario, and may reflect burning at the stake, a practice known ethnographically for the region (Jamieson, 1983). Death by hanging results in displacement of the basal sutures and fracture of the first or second cervical vertebrae (Waldron, 1996). Bodies of sacrificial victims may also be defleshed, disarticulated, intentionally broken and cut, burned, and used in artifact production (Lothrop, 1954; Jamieson, 1983; Warren, 1984; Pijoan *et al.*, 1989; Pijoan Aguadé & Lory, 1997). Pijoan (1998) reported that many of the sternums recovered from a mass burial at Tlatelolco had been cut transversely in half, possibly as a result of removal of the heart during human sacrifice.

Body position indicative of executed and sacrificed individuals includes placement with the face down (Fowler, 1984), tightly flexed fingers (Waldron, 1996), wrists and ankles close together indicating the individual was bound (Lothrop, 1954; Merbs, 1989), and burial of several individuals in a single grave, sometimes stacked in rows (Lothrop, 1954; Billard, 1991). At Venado Beach, Panama, human remains were stacked, suggesting they were dead prior to burial, while others were found with their mouths open or biting their fingers, indicating movement after burial and suggesting these individuals were buried alive. A 16th century account of burial customs in this area by Fernández de Oviedo described the suicide or sacrifice of servants by poison or by being buried alive while drunk, in order to accompany their masters in the next life (Lothrop, 1954).

At the late Classic site of Electra in San Luis Potosí, Mexico, human remains with cut marks and perimortem damage indicating dismemberment, defleshing, and cannibalism were found in a deposit sealed beneath several clay floors (Pijoan Aguadé & Lory, 1997). The remains were mixed with pot sherds, faunal bones, and red pigment placed over a burned artificial mound. Based on the context and modification of the remains, as well as documentary evidence, Pijoan Aguadé & Lory (1997) suggested that these remains represented human sacrifice associated with building construction. Human remains from beneath administrative buildings at the Mayan site of Utatlan were also interpreted as victims sacrificed in the dedication of new buildings (Solano, 1998).

Ritual artifact production

Human skeletal remains can be modified into artifacts by cutting, carving, drilling, polishing, and decoration with metal or stones. Such artifacts may be ornamental (Dixon, 1959; Williams, 1975; Jamieson, 1983), play a part in mortuary rituals (Baby, 1961), be included with burials (Hester, 1969; Hohmann *et al.*, 1985), or serve as trophies (Proulx, 1971; Seeman, 1988; Ravesloot & Spoerl, 1989; Simon, 1992; To, 1998). Trophy skulls are characterized by holes drilled through the top or bottom for attachment of a handle, and may be polished, carved, or decorated with paint, copper, or shell (Proulx, 1971; Ravesloot & Spoerl, 1989; Seeman, 1988; Pijoan *et al.*, 1989; Owsley *et al.*, 1994).

Cutting, drilling, and grinding of human skull fragments, including portions of the frontal and face, from an Ohio Hopewell site indicate they were originally tied together to form a mask (Baby, 1956). Human skulls were also used in the manufacture of gorgets at Iroquoian (Jamieson, 1983) and Late Adena and Hopewell sites (Baby, 1961), were modified into cups (Brothwell, 1981), and were carved and ground to form bone discs (Williams, 1975).

Long bones are modified by cutting, polishing, drilling, and carving to form beads or necklaces (Jamieson, 1983; Ravesloot & Spoerl, 1989; Maxwell, 1998), whistles (Baby, 1961), rasps (Ravesloot & Spoerl, 1989; Owsley *et al.*, 1994), mouthpieces for pipes (Hester, 1969), awls or other tools (Lothrop, 1954; Jamieson, 1983), and wands (Ravesloot & Spoerl, 1989). Two human femora recovered from Chiapa de Corzo in Mexico were covered with representations of human figurines and a serpent in deep relief, as well as elaborate incised designs (Dixon, 1959).

Discussion

Clearly, the same types of modification can occur as a result of different cultural behaviours: cut marks may be associated with mortuary practices, scalping, warfare, cannibalism, or the production of bone artifacts. The dilemma for the bioarchaeologist is how to identify specific taphonomic agents and the behaviours they represent when other processes can produce similar modifications. Careful examination should reveal differences in the *combination* of modifications, so that a taphonomic signature can be identified. In addition to recognizing the range of modifications which makes up a taphonomic signature, it is essential to look at other lines of evidence for interpreting human bone assemblages. This includes osteology, archaeological context, demographic composition, associated artifacts, and ethnohistoric accounts.

Mortuary practices

Although the same general types of taphonomic alterations can be found as a result of mortuary practices, warfare, and cannibalism, these three cultural behaviours result in very different overall patterns of modification. Secondary burial can involve weathering, carnivore gnawing, defleshing, and dismemberment, but Villa (1992) pointed out that there are no documented secondary burial practices that include perimortem trauma, unhealed weapon wounds, and intentional percussion breakage of long bones.

Bahn (1991, 1992) suggested that reported mortuary practices of Australian Aborigines exhibited the same pattern as supposedly cannibalized remains. These practices involved a period of exposure long enough for the body to decompose and/or dry, then defleshing, followed by breakage, selective collection of elements, and burial of multiple individuals in a single deposit. However, this would not account for the burning, pot polish, or even perimortem fracture if the bones had already become dry.

Additionally, the context of disarticulated remains identified as cannibalized suggests they were not deposited as part of a typical mortuary pattern. In the American Southwest, such remains were often unburied and are found in several different settings. In Europe they have been recovered from contexts identical with deposits of faunal remains.

Warfare and violence

Bullock (1991, 1992) argued that the set of taphonomic patterns identified as possible cannibalism in the American Southwest is the result of warfare, interpersonal violence, and corpse mutilation. Individually, many of the alterations observed in these assemblages could be explained as evidence of warfare or mutilation. Bullock failed to recognize, however, that the *total suite* of taphonomic characteristics used to define cannibalism is distinctly different from the set of patterns associated with warfare. In addition, he completely overlooked two of the criteria (percussion abrasions and under-representation of vertebrae) which are part of the cannibalism signature.

As the foregoing examples have demonstrated, warfare and cannibalism do share a number of taphonomic patterns, including perimortem trauma, cut marks, fragmentation, and mutilation. Although violence and mutilation does appear to be associated with remains interpreted as cannibalized in the American Southwest (Baker, 1990; Turner & Turner, 1992a, 1999), other taphonomic patterns such as percussion impact notches and abrasions, extensive fragmentation of long bones, and pot polishing do not characterize victims of violence and warfare (Villa & Mahieu, 1991; White, 1992; Turner & Turner, 1995). In addition, skeletal remains of individuals killed in battle often exhibit gnawing by carnivores (Owsley *et al.*, 1977; Milner & Smith, 1989; Blakely & Mathews, 1990; Willey, 1990; Milner *et al.*, 1991), while bone assemblages interpreted as cannibalized are characterized by extremely low frequencies or complete lack of carnivore gnawing (Turner, 1983; Villa *et al.*, 1986a; Baker, 1990; White, 1992). Clearly, no single taphonomic characteristic differentiates cannibalism from warfare; rather, it is the particular combination of characteristics which distinguishes cannibalized assemblages.

Witch execution

Some researchers have suggested that the pattern of bone modification interpreted as evidence of cannibalism in the Southwest reflects the ritual execution of witches (see Ogilvie & Hilton in this volume) (Darling, 1999; Ogilvie & Hilton, 2000). Surveys of Puebloan ethnography and historic accounts demonstrate that fear of witches has been very powerful in the Eastern Pueblos since contact with the Spanish, who believed strongly in witchcraft (Simmons, 1980; Baker, 1990; Darling, 1999; Ogilvie & Hilton, 2000). The extent of such beliefs prior to contact, and among the Hopi and Zuñi who are the likely descendents of the Anasazi, is less clear. Darling (1999) drew extensively on ethnographic accounts and folk tales from the historic and modern Pueblos and Navajo. The applicability of Eastern Pueblo groups as analogues for the Anasazi is uncertain, but there is no evidence for a Navajo presence in the Southwest during the Puebloan period.

Ethnographic and historic accounts of Puebloan witch execution have described numerous methods of killing a witch, including beating, burning, decapitation, being shot with arrows or guns, and hanging by the arms (Simmons, 1980; Baker, 1990; Darling, 1999). One of the primary witch execution rituals described by Darling (1999) involved the destruction of anthropomorphic figurines representing witches by the Bear Societies at Santa Clara Pueblo. He suggested that this metaphorical witch execution provided a model for identifying patterns of human bone damage. Darling provided no clear connection between such symbolic rituals and actual witch executions, and even the metaphorical execution he described involved only beating, cutting, and burning. While this could result in perimortem fracture, cut marks, and burning, the under-representation of vertebrae and the presence of pot polish are not accounted for. In addition, witch execution is said typically to involve only one or two individuals, while the deposits interpreted as cannibalism often represent groups of people.

Of utmost importance in the Puebloan witch execution ritual is the complete destruction of the body to ensure the witch cannot return. Ogilvie & Hilton (2000) have stated that recent cases of witch execution share the same patterns of bone damage shown in prehistoric remains from the Southwest, but have not provided specific examples. Both Darling (1999) and Ogilvie & Hilton (2000) have further suggested that witch execution is a better interpretation

than cannibalism for the more than 30 mass bone deposits from the Anasazi region. Their arguments rely heavily on analogy with ethnographic accounts and the use of witch execution for social control. A key argument against cannibalism for these researchers is the consistent identification of witches with cannibals and the socially unacceptable nature of such practices. Given the widespread presence of witches and their clear association with cannibalism, it is curious that these researchers will not consider cannibalism as a cultural practice, even by a socially deviant portion of the population.

The lack of a documented pattern of bone modification associated with witch execution, reliance on ethnographic analogues which may not be appropriate, and a failure to account for all of the taphonomic characteristics exhibited by Anasazi assemblages does not warrant an interpretation of witch execution. However, an important point made by these researchers is the possibly ritual nature of the mass bone deposits. The uniform way in which human remains were altered at these sites suggests standardized processing, and several of the bone assemblages are associated with ritual (kivas) and abandoned structures.

Cannibalism and ritual

The taphonomic signature for Anasazi mass bone deposits is virtually identical to that exhibited by nonhuman bone assemblages interpreted as food refuse, leading to the inference that the human remains were processed in the same way for the same purpose (Villa *et al.*, 1988; Villa, 1992; White, 1992; Dice, 1993; DeGusta, 1998). DeGusta (1998) (also see DeGusta in this volume) tested the presence or absence of cannibalism in Fiji by comparing food processing patterns with human remains recovered from midden and house contexts at the site of Vunda. Aside from extensive fragmentation, frequencies of bone modification to the human remains were lower than for faunal remains, and one category of modification was not present in the human sample. DeGusta (1998) concluded: 'The hypothesis of cannibalism is thus not supported for this assemblage. Instead, it seems likely that some of the "midden" human material really belongs with the burials, and that the damage is largely an incidental result of bodies being placed beneath houses'. This study demonstrates that examination of modification and context can distinguish taphonomic patterns produced by different cultural behaviours in the archaeological record.

Several researchers have noted the extreme degree of violence and fragmentation of the Anasazi bone deposits, which goes well beyond what is needed for consumption. Nass & Bellantoni (1982) asked: 'Why was it necessary to break the long bones into such small fragments to extract the marrow, and to completely destroy the faces and crania for retrieval of the brains?' Initial cases were considered episodes of starvation cannibalism, but the recognition of this taphonomic signature at more than 30 sites in the Anasazi region suggests something else was going on. Understanding why individuals were being systematically killed, butchered, and probably eaten is not the goal of this review, but many researchers now feel these episodes may have been tied to ritual practices (Baker, 1990; Turner & Turner, 1999; Ogilvie & Hilton, 2000).

Unfortunately, taphonomic analysis of human remains has not been a routine part of osteological investigation until recently. Because human skeletal remains are becoming increasingly less available for study in the USA and are usually reburied shortly after excavation, it is imperative that all possible types of analysis be performed, including taphonomy. As more researchers take note of taphonomic changes to human remains under varying circumstances, we will gain a better understanding of how human bone is altered by different processes and agents. As patterns of modification are documented, confusion as to how and why bone has been modified by human cultural practices should give way to more reliable interpretations of behaviour from human skeletal remains.

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