Journal of Archaeological Science 40 (2013) 2754–2770

Contents lists available at SciVerse ScienceDirect

Journal of Archaeological Science

journal homepage: http://www.elsevier.com/locate/jas

Should dates trump context? Evaluation of the Cave 7 skeletal assemblage radiocarbon dates

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ARTICLE INFO

Article history:
Received 31 January 2013
Accepted 31 January 2013

Keywords:
War
Intergroup violence
Radiocarbon dating
Dates and contextual evidence
Basketmaker II
Cave 7 skeletal assemblage

ABSTRACT

"Massacre" was the accepted interpretation for a prehistoric skeletal assemblage of around 90 individuals from Cave 7 in the SE Utah of the North American Southwest since the 1890s. Coltrain and others (*Journal of Archaeological Science* 39, 2220–2230) rejected this account based on a dispersed suite of AMS radiocarbon dates on purified bone collagen from the interred individuals. Since dates from skeletons exhibiting perimortem damage were scattered across some 400 radiocarbon years, Coltrain et al. argued for multiple interments of victims of violence and related kin spread across several centuries. The temporal placement of interment events in Cave 7 clearly cannot be known independent of radiocarbon assays but such assays should not be privileged above contextual information about which individuals were interred together unless verified by an independent dating laboratory. Only by ignoring important information about burial context in the 1893 field record can the dates of Coltrain et al. be accepted as accurate estimates of time of death. We redated residual collagen from 11 of the Cave 7 individuals because of significant contextual anomalies with some of the prior results. The new assays combined with contextual evidence demonstrate that some of Coltrain et al.'s dates are either too old or too young; the dates are neither sufficiently accurate (true estimates of sample age) nor sufficiently precise (small confidence intervals) to refute a single-event massacre or to confirm multiple interment events in Cave 7. Nonetheless, dates that meet these criteria disclose at least two interment events, a large one of mostly adult males, many exhibiting perimortem damage (a massacre assemblage), and a small one consisting of an adult female with three children. A third interment event of a few adult females and child is possible based primarily on context since the date distribution in this case overlaps substantially with that of the massacre victims; context also hints at other interment events. Aside from chronology we clarify the number of Basketmaker individuals interred at the site and the incidence of perimortem violence. A single-event mass killing continues to be the most likely interpretation for around 58 individuals, mostly adult males (at least 35) but also adult females and children. This incident occurred between cal. AD 20–80 and doubtless had a significant social impact at the time because of its scale, reverberating throughout the early farming communities of the Southwest.

1. Introduction

In 1893, Richard Wetherill and his Hyde Exploring Expedition crew excavated "Cave 7," a small alcove in SE Utah. Their findings were significant for two reasons: first, they included the first clear stratigraphic evidence of older "Basketmaker" cultural remains underlying those of the Puebloan "cliff dwellers." Second, they yielded what seemed to be clear evidence for an ancient massacre of Basketmaker peoples. Skeletal remains of more than ninety individuals were recovered from the alcove and ultimately donated, along with other artifacts from this and other sites, to the American Museum of Natural History in New York City. A century later, those remains were examined by Hurst (artifacts) and Turner (skeletal remains), who concurred with Wetherill's interpretation that the assemblage included evidence for a Basketmaker massacre event (Hurst and Turner, 1993). Almost two decades later, that finding was challenged by Coltrain et al. (2012) based on their radiocarbon dating of a significant sample of the human remains, results of which were distributed across several centuries, suggesting to them that the Cave 7 burial assemblage represents a persistent pattern of episodic, small-scale violence rather than a single large-scale massacre. In this article, we assemble new radiocarbon dates and detailed provenience/association evidence from Wetherill's documentation to show that Wetherill's interpretation of a large-scale massacre was likely correct; that Coltrain et al. were also

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http://dx.doi.org/10.1016/j.jas.2013.01.034

correct to a degree in their argument that not all of the remains represented a single massacre; and that radiocarbon dates should not trump documentary evidence, but must be interpreted cautiously and rigorously in the context of field documentation regarding detailed provenience and association.

This paper concerns dating but it is ultimately about the social scale of violence represented at an early time period for the Southwest, an interval when farming groups were becoming established. Cases like Cave 7 are significant in the archaeological study of the causes and effects of warfare (e.g., Arkush and Allen, 2006; Gat, 2006; Keeley, 1996; Kelly, 2000, 2005; Lambert, 2002; Martin and Frayer, 1997; van der Dennen, 1995). Despite some obvious limitations stemming from the gap between the material record and inferred behavior, archaeology has demonstrated that lethal intergroup conflict, or "intercoalitional violence" (Patton, 2000:417), was a facet of life in pre-colonial and pre-state times, thereby providing a useful counterpoint to the contentious ethnographic record about war in "simple" societies (cf. Ferguson and Whitehead, 1992; Keeley, 1996; van der Dennen, 1990). With access to great time depth, archaeology can contribute to an understanding of the ecological, technological, and social conditions that might have fostered or supported intercoalitional violence. It can help test explanations such as resource competition, thereby allowing inferences about the adaptive value of the behavior and the contexts that made this possible.

Documenting unambiguous evidence of prehistoric warfare is essential, skeletal remains that exhibit traumatic injuries are indispensible in this regard (Walker, 2001), and massacre assemblages are the *sine qua non* for war. As confirmatory evidence, prehistoric massacre assemblages merit detailed study to document the health, nutritional status, and demographic profile of the deceased, since these factors are central to an understanding of the causes of lethal intergroup aggression. Direct dating to situate the remains within detailed reconstructions of the social and natural environment is also a critical step. Single individuals with perimortem damage indicative of violence can be simple homicide victims, but when numerous skeletons with such damage are interred together and embedded with projectile points, intergroup violence becomes the most probable cause. Direct dating of the remains might be done in an effort to test for contemporaneity and thereby bolster or refute a massacre claim, but because of the statistical nature of radiocarbon dates combined with the need for calibration, it is virtually impossible to be certain that individuals with identical ages, even with exceedingly low error terms, had strictly contemporaneous times of death (a few hours or days at most) in order to qualify as a massacre. Such an inference can only be made based on excavation context, thus the field documentation (notes and photos) and observations by those involved are critical.

In the North American Southwest massacre assemblages are moderately well represented during the Puebloan periods of the Christian era, after about AD 700 (e.g., Billman et al., 2000; Kuckelman et al., 2002; LeBlanc, 1999; Potter and Chuipka, 2010; Turner and Turner, 1999). Prior to this, during the Basketmaker II period (ca. 1000 BC–AD 500, the northern American Southwest's equivalent to the pre-pottery Neolithic of the Levant and Near East), massacre assemblages are rare, represented by just two finds: Cave 7 in SE Utah (Hurst and Turner, 1993) and Battle Cave[1] in Canyon del Muerto, NE Arizona (Turner and Turner, 1999) (Fig. 1). There is a plethora of other evidence for conflict at this time (see reviews in LeBlanc, 1999; Matson and Cole, 2002) but the social scale represented is not necessarily indicative of war as with massacre assemblages since it could result largely from dyadic interactions. Violent conflict between individuals can escalate to group-level conflicts, but whether this occurred during the Basketmaker II period depends on the veracity of the claims for the two massacre assemblages, with Cave 7 of special import.[2]

The Cave 7 skeletal assemblage looms large in Southwestern archaeology, both in the history of the discipline and, more importantly, for the social and theoretical ramifications of the remains. The excavators' interpretation of Cave 7 as a massacre site went unchallenged until 2012 when the *Journal of Archaeological Science* published a paper by Coltrain and her colleagues that presented a suite of AMS radiocarbon dates seemingly inconsistent with a single event. The authors rejected the massacre scenario, arguing instead that the Cave 7 skeletal assemblage represents a series of multiple interments of victims of violence spread across several centuries. "Rather than an anomalous single-event massacre, the Cave 7 radiocarbon dataset suggests that raiding and intragroup,[3] male/male violence was episodic among Basketmaker groups in southeastern Utah" (Coltrain et al., 2012:2220).

Their argument looks convincing at casual glance, since the dates are dispersed across several centuries, most significantly for individuals exhibiting obvious evidence of violent death. Yet the dates can only be accepted as accurate estimates of individual sample age (time of death), within the range of their error terms, if important information on excavation context is ignored. In this paper we start by clarifying the nature of the Cave 7 sample and the frequency of violence represented. We then document several critical contextual anomalies with the existing suite of dates, problems that strongly indicate that not all of the existing assays should be treated as equally valid. We then present new assays on residual collagen from a sample of the Cave 7 burials that verify our suspicions concerning the accuracy of some prior dates. We make the case that (1) dates should not necessarily trump context, even for hastily excavated and poorly documented remains, especially when uncorroborated by additional assays from a different laboratory; (2) the previous assays are neither sufficiently accurate (true estimates of sample age) nor sufficiently precise (small confidence intervals) to support the argument for multiple interment events in Cave 7 (some of the previous assays are either too old or too young); (3) dates that meet these criteria nonetheless show that there were at least two interment events that can be identified based on the radiocarbon technique with the possibility of others

[1] This site should not be confused with a site in Allen Canyon, southeast Utah, that was excavated by Charles B. Lang and others in the middle 1890s and referred to in their documentation as "Battle Cave" (Hurst, 1996; Blackburn and Hurst, 1994). Collections from that excavation are curated as part of the Martin Ryerson Collection, at the Field Museum of Natural History in Chicago. The site's name appears to have been inspired by a hastily erected wall thrown up across the front of the alcove, rather than an assemblage of obviously traumatized burials.

[2] There are a number of Basketmaker II mass graves containing 8 or more individuals from various places on the Colorado Plateau that might be seen as another piece of evidence for conflict since such die offs seem inexplicable except by epidemic. Epidemics are far more likely during later periods when population levels were higher and people lived in more crowded conditions yet mass burials other than massacre assemblages are generally absent after Basketmaker II. We currently doubt that mass graves lacking obvious signs of trauma are evidence of conflict but instead result from the repeated use of a place for interment of family members; we acknowledge, though, that some of these mass burials lack the sort of detailed analysis necessary to totally dismiss the possibility of violent death.

[3] Basketmakers may well have experienced *intragroup* conflict, that is violent encounters among members of a defined residential (social) group such as represented by the Yanomamo axe fight filmed by Timothy Asch and Napoleon Chagnon (http://der.org/resources/study-guides/the-ax-fight.pdf), but the sort of physical trauma exhibited by many of the male skeletons at Cave 7 more readily matches expectations for *intergroup* conflict—violent encounters between members of distinct residential (social) groups although still part of the same cultural/ethnic/linguistic tradition (internal war following Otterbein, 1968). Raiding by definition is an intergroup behavior.

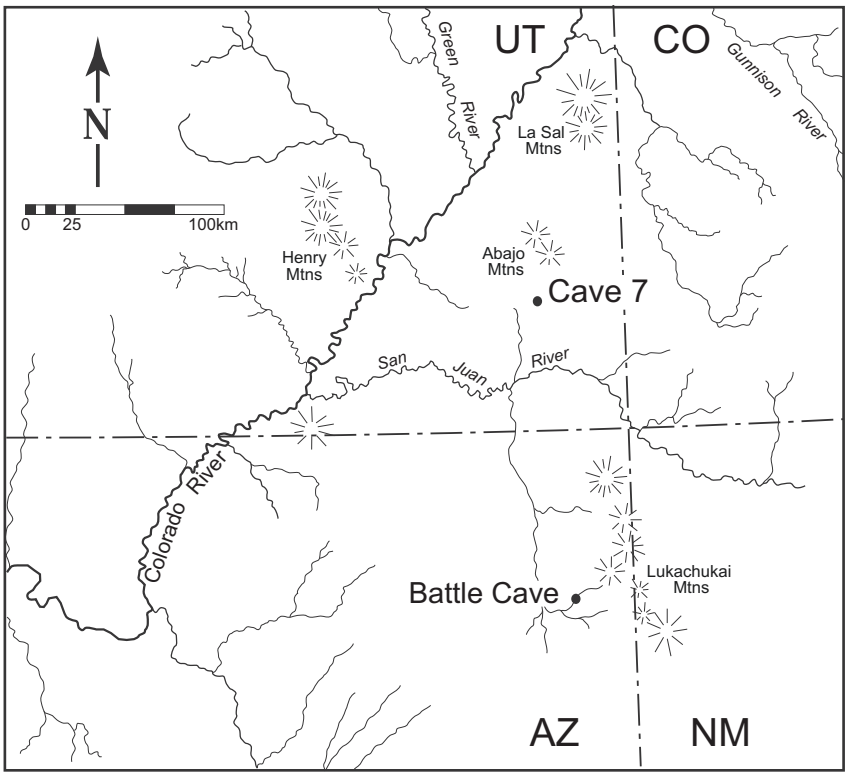

Fig. 1. Map of the four corners area of the north American Southwest showing the location of Cave 7 and Battle Cave.

based largely on contextual evidence; (4) one interment event accounts for a majority of the skeletons and qualifies as a massacre assemblage—it involved mostly adult males, many of which exhibit perimortem damage, along with adult females and children; (5) the implications of social scale represented by the massacre assemblage calls for additional research including a refinement of chronology for the rest of the remains, but the radiocarbon technique cannot resolve all questions about the number and sequence of interment events in situations like Cave 7; and (6) a full understanding of the Cave 7 skeletal remains requires careful attention to the existing contextual evidence in concert with the results from new analytical techniques.

2. Wetherill's Cave 7

After the initial fervor over the Cave 7 find had subsided and the existence of a Basketmaker culture predating the Pueblos was verified by more scientifically focused and well-published excavations (Guernsey and Kidder, 1921; Kidder and Guernsey, 1919), the Cave 7 remains were largely forgotten until interest in old collections surfaced in the Southwest during the 1980s. Indeed, the actual location of the site was soon lost to science until almost 100 years after it was excavated (Hurst and Turner, 1993:148–156). Fortunately, however, the skeletal assemblage, artifacts and field catalog were given to the American Museum of Natural History (AMNH) and accessioned there in 1899, thus allowing the sort of modern day investigations reported by Turner (Hurst and Turner, 1993; Turner and Turner, 1999) and Coltrain et al. (2012).

Cave 7 (42SA22180) is a small, west-northwest-facing rockshelter 32 m wide by 12 m deep (Fig. 2) that Richard Wetherill and other members of the Hyde Exploring Expedition excavated near the end of 1893. For horizontal control, they subdivided the shelter into six sections that each measured about 12 feet wide, but of variable length as they extended from the shelter's backwall toward the dripline.[4] Unfortunately, except for some tiny schematic sketches in his artifact catalog that do not show his section divisions, there is no known surviving Wetherill map of the site. Nevertheless, using entries in his field catalog along with his other descriptions and field photos, we have been able to reconstruct the approximate location of these subdivisions as shown in Fig. 2. Wetherill numbered the sections starting at the south end of the shelter and ending with section 6 partially under the walls of a Puebloan structure. Near the end of work, he added another section on the north side of the masonry rooms, designated section 0.

The Cave 7 skeletal assemblage provided the first conclusive evidence of a culture predating the cliff-dwellers who built and occupied masonry pueblos like those that Wetherill had found at Mesa Verde.[5] These earlier people lacked the ceramic vessels made by Pueblo people, but their finely crafted coiled basketry prompted Wetherill to call them "Basket People," a term that evolved over several decades into the name that remains in current usage,

[4] Information in Wetherill's field documentation is somewhat ambiguous in regard to directionality, as he considered the alcove to be north facing, whereas it actually opens to the west-northwest. His "north" is therefore closer to west than north. For this reason, our directional references will not be perfectly consistent with those given in Wetherill's catalog.

[5] This aceramic, long-headed culture had actually been previously recognized by a former digging partner of Wetherill's, Charles McLoyd, who with C.C. Graham and others had conducted collecting expeditions into southeast Utah during the two years prior to Wetherill's Cave 7 discovery. McLoyd had clearly distinguished between the long-headed "Cave Dwellers" and the short-skulled "Cliff Dwellers", but lacked the clear stratigraphic evidence to show that the former significantly predated the latter. The importance of Wetherill's Cave 7 find lay not in his discovery of the culture we now call "Basketmaker," but in the clear stratigraphic evidence for its relatively greater antiquity.

"Basketmaker II" (see Hurst and Turner, 1993:147 for a discussion of name evolution).

A more significant aspect of the Cave 7 skeletal assemblage concerns evidence that many of the 90 or so individuals died as a result of violent conflict. This seemed immediately obvious to Wetherill, leader of the excavation; a few weeks after the find he wrote a letter saying that they had recovered over 90 skeletons many with "broken heads and arms" and skeletal elements pierced with projectile points (Hurst and Turner, 1993:145). A fuller account of the find appeared in *The Archaeologist* magazine in 1894, listing the total number of skeletons recovered at 92. Three of them were recognized as "cliff-dwellers" but the rest were identified as Basket Makers who were interred so close together in the central portion of the shelter that bones touched each other. "The number of skeletons found at one level and in one place would suggest a sudden and violent destruction of a community by battle or massacre" (H, 1894). So it was that Cave 7 became known to Southwestern archaeologists as a massacre site, one of three such finds identified in 1893 (Turner and Turner, 1999:Table 3.1). It is important to point out that Cave 7 was not a massacre where the victims were left lying where they had fallen, but one where survivors, perhaps related family members, remained at or returned to the scene and buried the remains, some in a moderately formal way with offerings.[6]

Specific details about the skeletal assemblage were not available until 100 years later, after Christy Turner published his findings from examining 61 of the burials (Hurst and Turner, 1993; also Turner and Turner, 1999:59–65). This number comprised 40 males, 15 females and six that could not be sexed, mainly subadults. Hurst and Turner (1993:171) concluded "that a high percentage, possibly all, of the Basketmaker individuals interred in Cave 7 were massacred." The intriguing implications of social scale and cooperation implied by the number killed (Hurst and Turner, 1993:168–169) appear annulled by Coltrain et al.'s (2012) rejection of the massacre interpretation.

2.1. The Cave 7 sample

The exact number of individuals that were interred in Cave 7 remains in doubt (Hurst and Turner, 1993). Fig. 1 of Coltrain et al. (2012) presents the calibration results for 96 samples, listing them all as Basketmaker burials. However, it is essential to distinguish between the individual skeletons or burials that Wetherill excavated and identified by field number (FN) and the skeletal samples that were radiocarbon dated, since the two are not isomorphic, even though Coltrain et al. (2012) treat them as such. In addition, the AMNH catalog numbers (CN) for the Cave 7 assemblage (all prefixed by 99 and written on most elements in ink) are not isomorphic with individual burials or with the samples dated by Coltrain et al. In a few cases AMNH assigned multiple CNs to the remains from a single individual and in a few cases where obvious comingled remains were included in a single FN, these were separated and given individual CNs or a letter appended to the primary number. Wetherill's catalog lists 88 skeletons and one group of skeletons mixed together, placing the total body count recognized by the excavators in the 90–92 range; this accords with most written accounts of the day by the principals involved. This total includes several obvious Puebloan skeletons that the excavators recognized by shallow depth of burial, associated pottery, and/or cradle board flattening of the skull (something not seen with the Basketmakers). Thus, the number of individual Basketmaker skeletons exhumed from Cave 7 is very unlikely to have totaled 96.

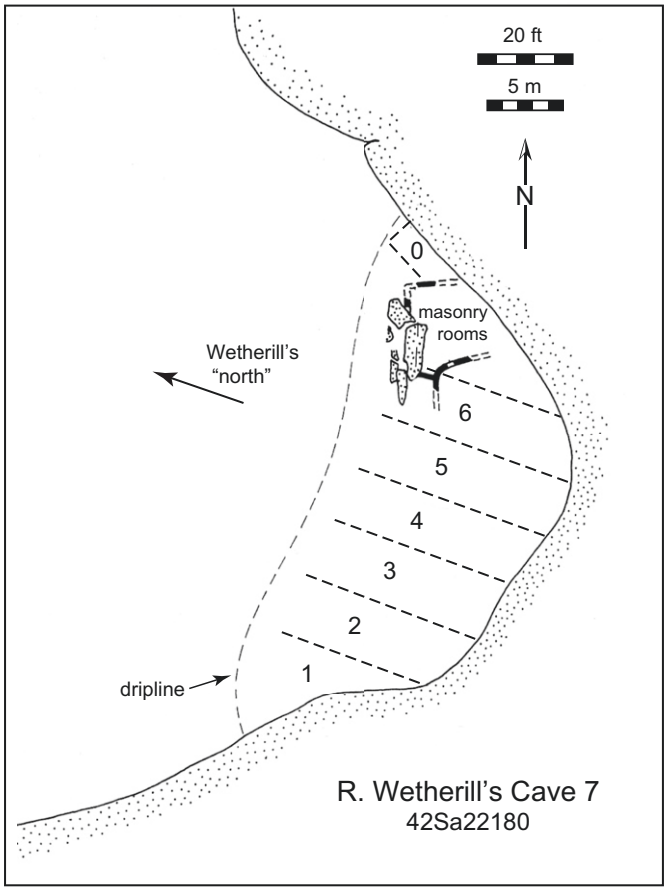

Fig. 2. Plan map of Cave 7 from Hurst and Turner (1993:Fig. 8.3) with the addition of the probable approximate location of the sections that Wetherill used for horizontal control during excavation of the shelter.

Wetherill was explicit in two instances that the remains from multiple individuals were grouped together under a single FN, but many examples of this occur within the AMNH collections. When Coltrain sampled the remains (assisted by the senior author of this article), the elements for a single CN were laid out and examined to determine if only one individual was represented. Single individuals were common when considering major elements (long bones, scapulae, innominates, etc.) and ignoring occasional spare ribs and vertebrae, but in at least 17 instances it was clear that at least one additional individual was represented by more than just a few random bones. The mixing of elements could be partly a consequence of hasty excavation and mixing during field bagging (see Fig. 8.5 in Hurst and Turner, 1993), but also because many of the skeletons were heaped together or closely placed during interment. In instances of multiple individuals per CN, Coltrain often sampled each individual represented, usually using a

[6] If all or some portion of the buried individuals were victims of a single event conflict it is possible that individuals from both sides are represented, something that might appear consistent with differential burial treatment—the more formally buried and grave-good honored individuals representing the casualties incurred by the winning side, the skeletons tossed in a heap representing the casualties of the losers. We doubt that individuals from both sides are represented for a few reasons. First, accounts of massacres indicate that attackers rarely experience causalities unless they are detected first and in such a case the dead should consist just of warriors. Second, and more importantly, the dead of the winning side should not be those that were brutally beat and perhaps scalped, yet it is precisely these males that exhibit some of most formal burial treatment and inclusion of grave goods (e.g., Group 1 as discussed herein). Third, it seems likely that any dead of the winning side would not be mingled with those of the losing side but placed in a separate resting place. The differential treatment of buried individuals perhaps relates to their social status in life and to their relationships, kin or otherwise, with those who buried the remains.

common element to obtain an MNI. There were 12 cases of two individuals per CN, four cases of three individuals per CN and one case of six. The latter was a collection of infant remains that did not have a Wetherill FN and may represent loose elements from infants that were present on or around adult skeletons.

In addition, the total count of individual FNs that were dated and reported by Coltrain et al. (2012) is 72 rather than Wetherill's 89, which means that some of the individual Basketmaker burials were not sampled. The shortage of Wetherill-identified burials occurred primarily because some of his FNs assigned to skeletons evidently lack CNs (11 cases), but also because some were avoided or simply missed (4 cases: FN55, 128, 167, and 287). Burial 55 was purposefully avoided, since it was known to be Puebloan and there is some number confusion with 167. The adult male of FN 128 would have been an important addition. This individual had a dart point embedded in a vertebrae, but the wound had largely healed over around the stone point (Fig. 3; the vertebra is CN 7444, with CN 7447 assigned to the rest of the skeleton). After surviving the violent incident that resulted in the back injury, this man died at or near Cave 7 and formed part of the evident massacre assemblage, judging by the fact that his "head had been severely mutilated" at time of death (Hurst and Turner, 1993:180). Excluding this individual means that Coltrain et al. (2012) omitted one additional, obvious victim of violence.

These issues suggest that the 96 samples dated by Coltrain et al. (2012) probably contain a number of cases of multiple assays on single individuals, perhaps especially with infants and young children, but also several adults. The only way to limit duplication of single individuals while also ensuring that all individuals are actually sampled is to first inventory all the remains and try to match missing elements from given FNs across CNs, analyzing the assemblage as a whole at one time rather than

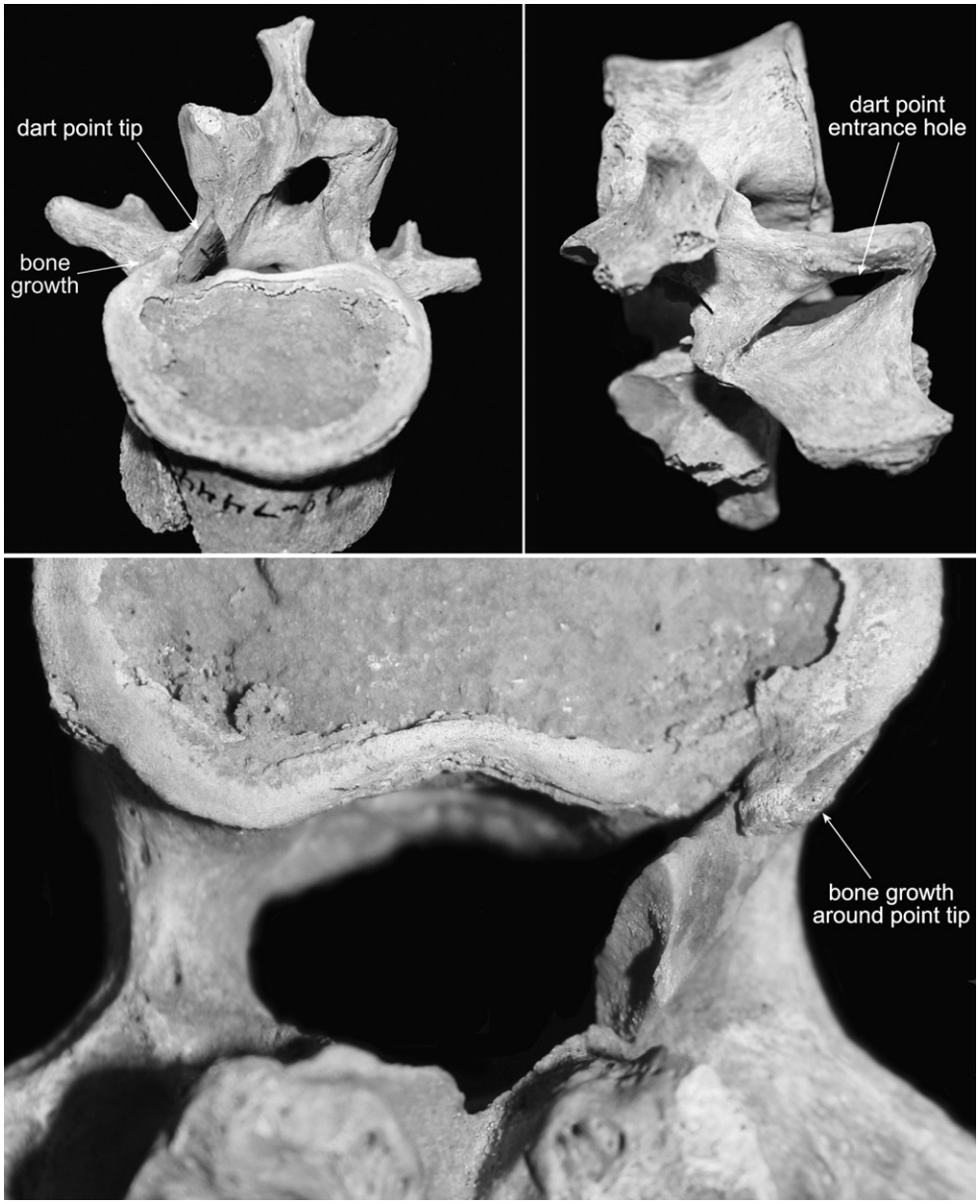

Fig. 3. Images of vertebrae with embedded dart point tip (AMNH 99–7444) from skeleton 128 (AMNH 99–7447). The individual lived with the injury for years as evidenced by considerable bone growth around the point. The entry wound has not closed but exhibits bone growths around the projectile point. This indicates that the point midsection was still within the bone at the time of burial, but evidently slipped out during or after excavation (photos by Phil Geib; collections of the American Museum of Natural History).

individually sampling each CN or FN. This would be a monumental undertaking and certainly Coltrain cannot be faulted in this regard. But because the 96 dates come from an unknown number of individuals, likely fewer than 90, Coltrain et al.'s (2012) statements about the frequency of trauma or other variables of interest must be qualified.

For example, the authors state that "whereas, Hurst and Turner report 29 burials (48%) with perimortem damage, our dataset recognizes only 20 of these or 21% of the Cave 7 BM II study population as likely perimortem trauma victims" (Coltrain et al., 2012:2223). The 21% comes from assuming that the 96 dated samples are equivalent with 96 separate individuals, which cannot be the case. Not only is the denominator inflated in this instance, but the numerator has been reduced by excluding some obvious victims of violence such as the previously mentioned burial 128.

Table 1 presents our best estimate for the number of Basketmaker II skeletons that were interred in Cave 7, a total of 89. These individuals are identified as adults (includes subadults) of male, female, or unknown sex, or as children (infants and children too young to be sexed). The individuals are tallied according to which cave section they came from, with Sections 2, 3, and 5 accounting for over 70% of the individuals (see Fig. 2). Our count is based on trying to eliminate duplication and resolve contradictions that exist among Wetherill's FNs, AMNH catalog notes, Turner's observations (Hurst and Turner, 1993) and the information presented by Coltrain et al. (2012), supplemented by our own notes and photographs of the collection. Wetherill's field catalog provides the essential start for this process but his account has to be rectified against what is actually within the collections at AMNH. Adding to this are problems with misnumbering, both in the original field catalog and at AMNH, and the mixing of remains across burial lots that Wetherill recorded as single individuals.

It is possible that our estimate of 89 excludes some children, since their skeletal remains were far more scattered and fragmentary and perhaps less likely to be individually identified by excavators. Nonetheless, it also seems likely that Coltrain et al.'s (2012) count of 23 infants and children, a full 24% of their dated sample, contain duplicate dates on single individuals, especially since many of their samples came from mixed collections that represented just partial skeletons; indeed, the Cave 7 assemblage overall contains few if any complete or nearly complete infant/child skeletons within a single CN or FN. The six dated child/infant specimens from CN 7414, which lacks any FN or provenience information other than the site, are also likely represented in burials with other FNs and hence were not counted in Table 1. As a result, we obtain an estimate of 19 child/infants, which is fewer than what Coltrain et al. (2012) recognized but still more than Hurst and Turner (1993:Table 8.1) identified. Likewise, our estimated number of males is lower than Hurst and Turner's tally, but still more than Coltrain et al. (2012), with males accounting for about half of the dead. There are likely even more males among the unsexed adults.

Table 1
Conservative count of individual Basketmaker II skeletons in the Cave 7 assemblage.

Cave Section	Male		Female		Adult, unsexed		Child		Total	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%
0	3	6.8	0	0.0	1	10.0	0	0.0	4	4.5
1	3	6.8	1	6.3	2	20.0	2	10.5	8	9.0
2	17	38.6	5	31.3	4	40.0	5	26.3	31	34.8
3	15	34.1	3	18.8	0	0.0	1	5.3	19	21.3
4	0	0.0	0	0.0	0	0.0	1	5.3	1	1.1
5	3	6.8	3	18.8	3	30.0	5	26.3	14	15.7
6	0	0.0	4	25.0	0	0.0	1	5.3	5	5.6
Unknown	3	6.8	0	0.0	0	0.0	4	21.1	7	7.9
Total	44	100.0	16	100.0	10	100.0	19	100.0	89	100.0
Col. %	49.4		18.0		11.2		21.3		100.0	

2.2. Assessment of violence frequency

Table 2 presents information on the number of skeletons that exhibited perimortem damage. We acknowledge that evidence of violence might not be equally registered in the skeletons of all individuals regardless of age or sex, that the elements of different individuals have unequal chances of preserving such indications (e.g., an unfused and thin-walled infant skull vs. that of an adult male), and that the excavators, who were working rather hurriedly and not screening, likely did not recover all remains equally. It is also important to distinguish between those individuals that lack skeletal evidence of violence and those for which the information is simply unavailable, either because no detailed examination has been done (most common) or because the remains were too fragmentary or incomplete to do so. To calculate an informative proportion of trauma victims in the assemblage, it is important to exclude those that are indeterminate, and they account for 38% of the assemblage. Table 3 thus leaves out the unknowns of Table 2 and presents the information about perimortem damage according to sex.

In both Tables 2 and 3, we have placed individuals with glaring evidence of violent death in the "obvious" category. The "possible" category includes individuals that Hurst and Turner indentified as potentially having some perimortem damage such as the young adult male skeleton of FN189 that exhibits "minor breakage at left nasal bone area" (Hurst and Turner, 1993:181) and that Wetherill noted had a bone awl under the left breast. As Hurst and Turner (1993:164) discuss, "awls" were deployed as "bone daggers" in several cases at Cave 7 and skeleton 189 might also have been stabbed with one although there is evidently no telltale skeletal damage in this case. Coltrain et al. (2012:2223) excluded FN189 and some other individuals with possible trauma from violent death because they found the evidence questionable. The subadult skeleton of FN100 is another example. Coltrain et al. (2012) list this individual as lacking any evidence of violence, yet Hurst and Turner (1993:178) identify it as exhibiting "one blow possible to basal occiput" and Wetherill notes that a projectile point occurred in the right ribs. Given the overall Cave 7 context, this is perhaps sufficient cause to suspect death by violence.

As another example, Coltrain et al. (2012) exclude from the trauma class the young adult female of FN103, despite a dart point embedded in one of her vertebrae and another point tip in the back area (Hurst and Turner, 1993:178). The reason given by Coltrain

Table 2
Count of individual Basketmaker II skeletons in the Cave 7 assemblage of Table 1 with perimortem damage according to Hurst and Turner (1993). Percentages are calculated by cave Section (within row).

Cave Section	Obvious		Possible		None		Unknown		Total	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%
0	2	50.0	0	0.0	0	0.0	2	50.0	4	4.5
1	1	12.5	0	0.0	2	25.0	5	62.5	8	9.0
2	7	22.6	5	16.1	6	19.4	13	41.9	31	34.8
3	10[a]	52.6	0	0.0	7	36.8	2	10.5	19	21.3
4	0	0.0	0	0.0	1	100.0	0	0.0	1	1.1
5	1	7.1	1	7.1	6	42.9	6	42.9	14	15.7
6	0	0.0	1	20.0	2	40.0	2	40.0	5	5.6
Unknown	0	0.0	0	0.0	3	42.9	4	57.1	7	7.9
Total	21	23.6	7	7.9	27	30.3	34	38.2	89	100.0

[a] This count includes the female skeleton 103 with dart point sticking in backbone although the cranium was undamaged.

Table 3
Count of individual Basketmaker II skeletons in the Cave 7 assemblage by sex for which an assessment of perimortem damage was made by Hurst and Turner (1993); excludes the "unknowns" of Table 2. The child column includes individuals too young to be sexed and consists mostly of infants and young children.

Cave Section	Obvious		Possible		None			Total	
	♂	♀	♂	♀	♂	♀	Child	*n*	%
0	2	0	0	0	0	0	0	2	3.6
1	1	0	0	0	1	0	1	3	5.5
2	7	0	3	2	5	1	0	18	32.7
3	9	1	0	0	5	2	0	17	30.9
4	0	0	0	0	0	0	1	1	1.8
5	1	0	1	0	1	3	2	8	14.5
6	0	0	0	1	0	2	0	3	5.5
Unknown	0	0	0	0	3	0	0	3	5.5
Total	20	1	4	3	15	8	4	55	100.0
%	36.1	1.8	7.3	5.5	27.3	14.5	7.3	100.0	
Summed %	38.2		12.7		49.1			100.0	

et al. (2012) for excluding this individual is that the person evidently recovered from the wound (citing an unpublished manuscript by Douglas W. Owsley and others). But the person that survived with a dart point embedded in their back was Burial 128 not 103. Even Wetherill made it clear that he found two individuals with dart points embedded in their backs: "six of the bodies had stone spear heads in them…in one joint of the backbone of skeleton 103 a spear point of stone sticking into the bone at least an inch. The same thing occurs with skeleton 128 but it seems that this one did not die from the wound as the cut in the outside of the bone has partially healed' (Wetherill, 1893 in Hurst and Turner, 1993:145). Skeleton 103 alone disproves the claim of Coltrain et al. (2012:225) that "no adult females…appear to have sustained perimortem injuries." The skull of burial 103 might not have been damaged, but she clearly died violently. Being conservative in the attribution of violence has merit, but if males were singled out for bludgeoning then slight perimortem damage on females might be just as indicative of violence. A convincing claim for a lack of perimortem damage to female skeletons requires a thorough osteological study. Even then, it's worth recalling Walker's (2001:584) caution that "the frequency of injuries detected in ancient skeletal remains is just the 'tip of the iceberg' in terms of the actual incidence of injuries."

Of the 55 individuals for which a determination of perimortem damage was made, 38% exhibit obvious evidence of violence and another 13% exhibit possible damage, together representing a total of 51% or just over half of the skeletons that have been assessed in this regard. Just under half of the 55 lacked any osteological traces of violence but it is worth noting that Wetherill observed dart points, knives, or bone awls among the bones of some of these. The individuals with obvious perimortem damage are all male except for the previously mentioned skeleton 103 with a dart point embedded in a vertebra. Although killed and buried at the site, she lacked the sort of facial trauma many of the males received, suggesting that this practice was male biased.

2.3. The dates

Coltrain et al. (2012:Table 1) report AMS radiometric assays on collagen extracted from whole bone fragments of 98 skeletal samples from Cave 7. The samples were prepared and isotope measurements obtained according to the procedures presented in Coltrain et al. (2007:305–309). Purified bone collagen was submitted to the NSF-Arizona AMS Laboratory which combusted the collagen, converted the gas to graphite, and measured the ratio of $^{14}C/^{13}C$. The results were converted to conventional radiocarbon years using Coltrain's measured $\delta^{13}C$ values for correction. The objective of this project was the timing and intensity of preceramic maize use (Coltrain et al., 2006, 2007), and radiometric dating was key for chronological ordering of the isotope values. The project was not specifically designed to test the assumption that Cave 7 was a single-event massacre site, although this is ultimately what occurred. Science often progresses in such a manner but as new objectives come to the fore it is important that the techniques of investigation are adequate to the task.

The 98 assays on Cave 7 bone samples range in age from 2086 ± 86 BP to 1080 ± 40 BP with most clustered between 1980 and 1780 BP (Coltrain et al., 's 2012:Table 1, Fig. 1). Fig. 4A provides a date histogram based on the midpoint of conventional radiocarbon years and 50-year intervals. Since the two youngest assays are on Puebloan burials from upper deposits in Cave 7, they will not be further discussed. The histogram also shows the frequency of individual skeletons that exhibited obvious perimortem skeletal damage, chiefly to the cranium, damage documented by Turner and verified during the skeletal sampling at AMNH. As noted above, this likely does not include all the individuals that might have died violently at the site but rather just those that showed the most glaring cranial trauma. Several incidences of minor cranial damage noted by Turner were dismissed by Coltrain et al. (2012:2223),

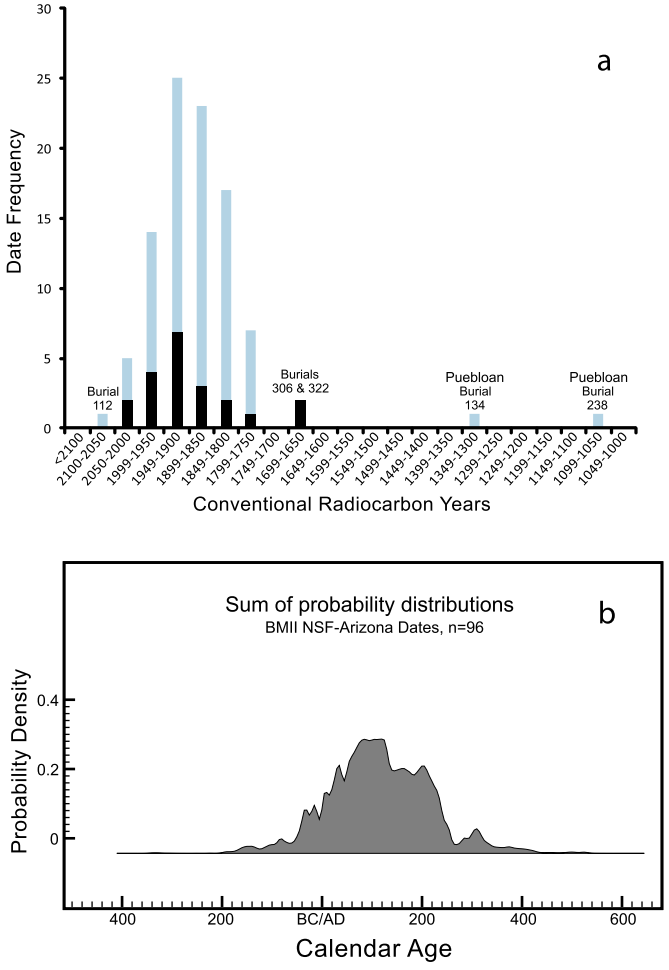

Fig. 4. Summary graphs for the 96 AMS radiocarbon dates obtained by Coltrain et al. (2012) on the Cave 7 Basketmaker II skeletons. Graph "A" is a histogram based on midpoints of conventional radiocarbon years using 50-year increments; the frequency of individuals exhibiting obvious evidence of violent death are displayed by black bars. Single outlying skeletons are identified using Wetherill's field number including two Puebloan burials. Graph "B" is a sum of the calibrated probability distributions of all 96 Basketmaker II dates.

which is partly why their number of violently killed individuals is lower than the 29 reported by Hurst and Turner (1993).

A sum of the probability distribution for the 96 Basketmaker II dates of Coltrain et al. (2012) reveals a continuous distribution with no obvious indication of multiple peaks, as might be expected if several different burial events were represented (Fig. 4B). The histogram shows an approximate normal distribution peaking between 1950 and 1850 BP or 80 and 120 cal. AD. The entire date span includes violent deaths. The two Basketmaker skeletons with the most recent assays (306 and 322) exhibit perimortem damage, as do the two Basketmaker skeletons with the oldest assays (81 and 137); the very oldest Basketmaker date is for an infant (skeleton 112),[7] and only adults exhibited signs of violent death.

Given that the 96 Basketmaker skeletal dates span some 500 calendar years, statistical proof to test for contemporaneity (Ward and Wilson, 1978) is essentially an academic exercise. As Coltrain et al. (2012:2223) demonstrate, the dates fail to pass the test at the 0.05 critical limit. This continues to be true even if the most extreme outliers on either side of the distribution are removed. Since the individuals exhibiting obvious perimortem violence extend across virtually the full range of the date distribution, it likewise comes as no surprise that a test for contemporaneity among the trauma victims also fails at the 95% level (Coltrain et al. (2012:2223, 2226). They conclude that since the pooled dates are statistically different, then such dates could not have been generated by a single event: "Cave 7 radiocarbon data do not lend strong support to the argument that a single-event massacre resulted in the mortuary assemblage recovered by Richard Wetherill" (Coltrain et al., 2012:2226).

In the last section of their article, Coltrain et al. (2012) address other (non-chronometric) lines of evidence that might support the massacre scenario, and then offer what they call a "plausible alternative to the massacre hypothesis." They conclude Cave 7 served as a special cemetery site for higher status males and their immediate kin who were victims of episodic violence from raiding or disputes that occurred across a 500–700 year span of time (based on just date means the period represented would be over 400 years). Although the radiocarbon dates seem to support this conclusion, a close examination of the context of certain dated individuals indicates that some assays have to be in error.

3. Context and date anomalies

We agree with Coltrain et al. (2012:2229) that the Cave 7 burial assemblage "is anomalous in some respects," but also seemingly anomalous in this case are some of the AMS dates themselves. We contend that Wetherill's interpretation of the site cannot be justifiably dismissed until these date anomalies are resolved or corroborated by additional assays, preferably by an independent AMS facility.

Fig. 5 highlights some of these anomalies. It plots the 2σ calibrated ranges for all 96 Basketmaker II radiocarbon dates in sequence of oldest to youngest with date midpoints shown as either a black dot for individuals with obvious perimortem damage or a white dot for individuals that lacked this or for which such an assessment was never made. Four groups of skeletons are individually identified and also represented by different color fills of the calibrated date ranges. These four groups are based on Wetherill's field log, which identifies several examples of burials that occurred together spatially such that contemporaneity at death and interment is highly probable. Although there are other groups that could be considered in a similar manner, the four that we have highlighted are the most significant. We present new radiocarbon assays for group members to compare with previous results. The specific skeletons for which we have new assays are identified in bold type on the left side of Fig. 5.

Group 1 consists of 8 adult males laid side-by-side on their backs, partially flexed with knees drawn up and with heads all oriented toward the cave mouth (Fig. 6). This group was uncovered in Section 3 of the shelter at the 5 foot depth level. All but one of these individuals shows evidence of perimortem violence and most exhibit extreme cranial trauma (see Hurst and Turner, 1993:Figs 8.15–8.24). Several had been pierced by dart points (76, 80 & 81) and 79 had a large obsidian knife blade plunged through the left innominate and sacrum, pinning them together. As the excavation photo shows, these skeletons are so closely packed together that simultaneous placement seems hard to doubt. Dates on these individuals thus should form a relatively tight cluster. Yet the existing assays fall throughout the lower three-fifths of the date distribution and range from 2043 ± 46 BP (second oldest date of the 96) to 1878 ± 57 BP. A further inconsistency is that Burial 196 was recovered from the six feet depth of Section 3, which is stratigraphically below this group, yet it has one of the youngest assays at 1796 ± 58 BP.

Group 2 provides an especially strong case, since it consists of a young female (Burial 408) in Section 5 at a depth of 6 feet, with three children placed on her upper torso (Fig. 7). Hurst and Turner (1993:190) classify this individual as an adult while Coltrain et al. (2012:Table 2) place the age in the 12–15 range. This individual rested on her back in a tightly flexed position with knees on her ribs near chin and her feet at the pelvis. A child under 3 years of age (Burial 405) lay on the right arm of 408, another child (Burial 406) was on her chest, and an infant of 1–2 years (Burial 407) was on the left arm. Wetherill was duly impressed by this find and penned the following: "we found one interesting group, a mother with an infant on each arm and another lying on her breast with its head under her chin" (Hurst and Turner, 1993:146). If ever there should be a contemporaneous set of radiocarbon dates it would be from the individuals of this group, yet the date spread encapsulates that of the larger Basketmaker population, with the female ("mother" to Wetherill) near the very oldest end of the date distribution (2004 ± 48 BP) but the children in either arm dating a few hundred years later: 1838 ± 46 BP for FN407 and 1795 ± 42 BP for FN405. In order to accept the dates as accurate one would have to argue that when these infants were interred, the pit intruded on an earlier skeleton. What seems more plausible, a highly fortuitous intrusive set of infant burials nestled into and against an earlier adult burial without disturbing the bones or simply something amiss with the dates?

Group 3 consists of skeletons 239–244 plus 246. Wetherill characterized them as "all in pile, could not separate bones, heads were less than 1 foot apart, in row, faces up" (Hurst and Turner, 1993:182). Wetherill does not explicitly include 244, yet the description of 243 which is included says "bones of a child inside of ribs of woman or (illegible) 244," and the section and depth are the same (Section 2, six feet). Wetherill also does not explicitly include 246, but the description for this burial reads "Group of skeletons. Position unknown seems to have been thrown in pile…" and the provenience is also Section 2, six feet. The only group of skeletons that Wetherill indentified with this horizontal and vertical provenience is that of 239–244. Four of the skeletons, all male, have extensive perimortem damage to the skull. As with the two other groups, there is a wide spread in the dates, from 2004 ± 42 BP to 1831 ± 58 BP.

The final spatial group comprises skeletons 418–420, three adult females, one with infant (420), from the 6 foot depth of Section 6 (Fig. 8). Individual 420 is described by Wetherill as lying

[7] This infant (112) was found at just 4 feet in depth whereas most of the Basketmaker remains occurred at a depth of 5–7 feet.

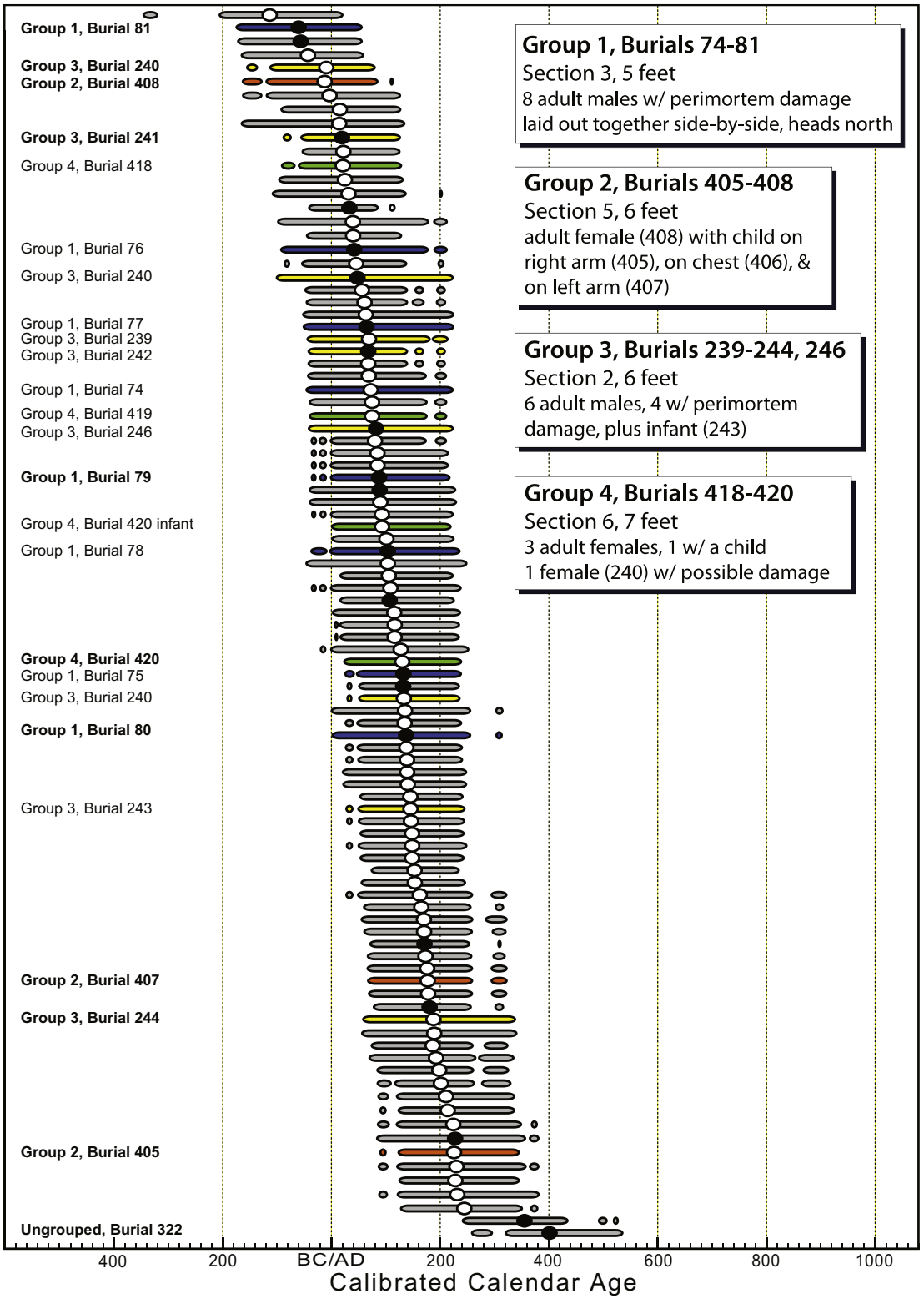

Fig. 5. Plot of calibrated 2σ ranges (gray or colored bars) and means (white or black dots) for the 96 AMS radiocarbon dates on Cave 7 Basketmaker II skeletal remains. Black dots denote individuals with evidence of obvious violent death. Different colored bars denote skeletons in close association or contact suggesting that the individuals within each of several different groups (identified in the inset text boxes on the right hand side) had been buried together and were thus contemporaneous. These individuals are identified on the left hand side with bold text indicating samples that we redated.

across 419, who was laid to rest parallel with 418. Hurst and Turner (1993:191) characterize the 420 adult female as possibly exhibiting minor traces of perimortem damage. The dates of this group exhibit far less dispersion, extending from 1975 ± 46 BP to 1884 ± 47 BP, or about 90 radiocarbon years between the means at opposite ends of the group range.

If one wanted to identify a series of temporally discrete interments in Cave 7 such as Coltrain et al. (2012) propose as their

Fig. 6. Photo of Group 1 skeletons in situ (University of Pennsylvania Museum #S4-140125).

alternative explanation for the assemblage, then the contextual groups identified by excavators make excellent candidates to investigate this possibility. This is especially true for those groups that contrast in their characteristics as do Groups 1 and 2 (or 3 and 2): male and exhibiting obvious signs of violence vs. female and young and lacking any signs of violence. The skeletons of each group were not just clustered together within the shelter but had the skeletal elements of different individuals physically touching. Yet the lack of contemporaneity in dates among group members supports the idea that the existing Cave 7 assays should not be considered as accurate estimates of some event or events. Taken together it seems plausible that the dates are relatively imprecise estimates of one or more episodes of interment.

In an attempt to deflect just this critique, Coltrain et al. (2012:2226) suggest that the "Cave 7 burials may have been disturbed prior to excavation in the site perhaps accounting for seemingly contemporaneous burial groups with wide within-group temporal spacing." Wetherill's notes actually do not allude to any such disturbance except in a few instances that he explicitly identifies, such as skeleton 412 where his notes say "face down, knees at chin, bones disturbed" (Hurst and Turner, 1993:190). Suggesting that the Basketmaker burials might have been

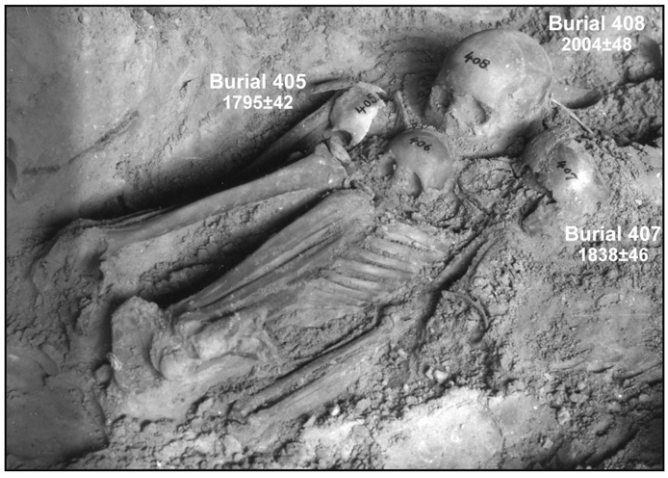

Fig. 7. Photo of Group 2 skeletons in situ (University of Pennsylvania Museum #S4-140109).

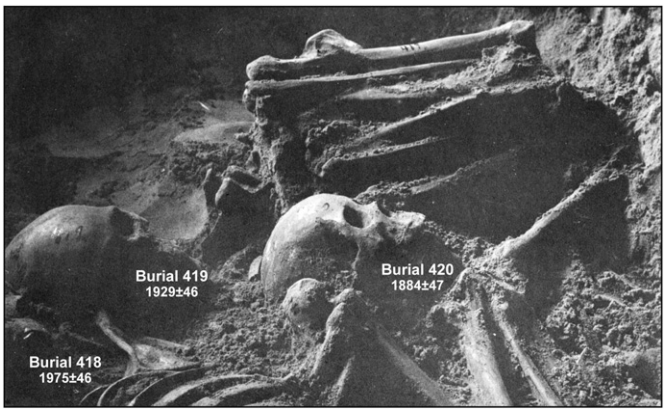

Fig. 8. Photo of Group 4 skeletons in situ (University of Pennsylvania Museum #S4-140101).

disturbed by intrusion of later Puebloan burials has no validity, given that just four Puebloan burials occurred and these were stratigraphically separated from the Basketmaker burials by 2–3 feet of clean sediment.

It is also not productive to simply dismiss Wetherill's observations and conclude that it is "not possible to determine from existing documentation whether burials such as those cited above were in primary context" (Coltrain et al., 2012:2226). By 1893 Richard Wetherill and his brothers were not novice excavators and even though their field techniques and notes are not up to today's standards this does not mean that they made no useful observations on context and associations. Coltrain et al. (2012:2226) believe that it is "difficult to address with confidence the sequence of interment events independent of radiocarbon assays" but we would add that it is also difficult to do this with assays that appear inaccurate and that have large error terms. Certainly Wetherill's burial groups provide excellent test cases for investigating the veracity of the existing Cave 7 determinations. We did this by obtaining new radiocarbon dates from an independent AMS facility on residual collagen for a sample of the Cave 7 skeletons.

4. New cave 7 dates

We dated 11 samples for this study, including 10 from the four groups just discussed and one from the youngest of the Cave 7 skeletons based on the dates reported by Coltrain et al. (2012). The latter exhibits severe perimortem cranial damage: "face sheared from vault" with "two penetration wounds in the occipital bone" (Hurst and Turner, 1993:188). These 11 samples are highlighted by bold text in Fig. 5. Because Coltrain had sufficient residual collagen for each of these 11 samples and graciously shared the remaining material, no new bone specimens had to be processed. We redated the remnant samples at the National Ocean Sciences Accelerator Mass Spectrometry Facility (NOSAMS) to compare with the original results obtained by the NSF-Arizona AMS Facility.

The new assays are presented in Table 4 as conventional radiocarbon years. The measured fraction modern for each sample was corrected using Coltrain's stable isotope measurements of sample $\delta^{13}C$. The calibrated 2σ date ranges presented in Table 4 were derived from OxCal version 4.1 (Bronk Ramsey, 2009) using the IntCal09 calibration curve for the northern hemisphere (Reimer et al., 2009) with 5 year rounding. For comparative purposes the table also includes the prior Arizona assays that were run on the same purified bone collagen. Wetherill's field number and other

Table 4
AMS radiocarbon assays for 11 bone collagen samples from Cave 7, SE Utah that were redated at the National Ocean sciences AMS facility. Calibrations are based OxCal 4.1 with 5 year rounding. NSF-Arizona dates on the same collagen samples are from Coltrain et al. (2012).

NOSAMS no.	Conventional date	Calibrated 2-sigma range	NSF-AZ date	Wetherill's field #	Burial Group	AMNH #	Coltrain's ACRF #
OS-97873	1930 ± 20	AD 25–230	1919 ± 47	79	1	99/7337	1781
OS-97874	1950 ± 20	AD 1–120	1878 ± 57	80	1	99/7338	1782
OS-97875	1980 ± 20	40 BC – AD 70	2043 ± 46	81	1	99/7339	1783
OS-97876	1980 ± 20	40 BC – AD 70	1951 ± 63	240	3	99/7354.1	1802
OS-97877	1950 ± 25	25 BC – AD 125	1831 ± 58	244	3	99/7355	1805
OS-98986[a]	1940 ± 35	40 BC – AD 130	1977 ± 43	241	3	99/7357	1807
OS-97884	1920 ± 30	AD 1–210	1650 ± 47	322	None	99/7381	1839
OS-97885	1930 ± 40	40 BC – AD 210	2004 ± 48	408	2	99/7392	1852
OS-97886	1890 ± 25	AD 55–215	1795 ± 42	405	2	99/7407	1867
OS-97887	1850 ± 25	AD 85–235	1838 ± 46	407	2	99/7408	1868
OS-97888	1900 ± 25	AD 25–210	1884 ± 47	420	4	99/7415	1880

[a] This is the second analysis of this sample; the first returned a date of 1860 ± 25 BP (OS-97878), which was significantly younger than the other two NOSAMS dates for Group 3 (χ^2 test failed at 5%, df = 2, T = 14.3, 5% = 6.0).

designations are listed for concordance purposes. Fig. 9 provides a visual comparison of the two sets of results.

As one might hope, there are clear correspondences between the results of both labs, yet there are noticeable differences as well. In general, the NOSAMS dates exhibit much less dispersion, being largely centered during the first two centuries AD, whereas the Arizona dates show far more dispersion with a few notable outliers extending into the early centuries BC and in the AD 200–500 range. Rather than considering individual dates, it is far more relevant to scrutinize the results by burial group. The dates of each group, both old and new, were tested for contemporaneity using the "R_Combine" feature of OxCal (Bronk Ramsey, 2009), which reports a χ^2 distributed test statistic (T) with n−1 degrees of freedom (df) and a critical region of 5% ($\alpha = .05$) (Ward and Wilson, 1978:23). We assume that members of a contextual group should be contemporaneous, thus assays that fail to pass the test (dates are statistically different at the 95% level) are indicative of poor accuracy in the dating of one or more of the group members. In contrast, if the assays pass a test for contemporaneity, especially if they do this with dates that have low error terms, thereby being consistent with the contextual evidence, then we consider these dates more reliable and likely more accurate.[8]

Three samples were redated for Group 1 to cover the full range of the previous date spread based on Coltrain et al.'s (2012) dates, from Burial 81 on the early side to Burial 80 on the late side, with Burial 79 in the approximate middle. As Fig. 10 shows, the three Arizona assays cannot be averaged, since they fail to pass the test for contemporaneity (df = 2, T = 6.1, χ^2 = 6.0, $\alpha = .05$). As evident from the graph, the prior date on Burial 81 is the problem; the other two Arizona dates overlap significantly in the 0–200 AD range. All three of the NOSAMS dates exhibit substantial overlap of their distributions and pass the test for contemporaneity (df = 2, T = 3.2, χ^2 = 6.0, $\alpha = .05$). These dates support Wetherill's field observations and the corroborating photo documentation that the violently killed adult males of Group 1 were interred together at the same time. The average of the three NOSAMS assays provides the best estimate as to when this occurred: 1953 ± 12 BP, which has a 2σ calibrated date range of AD 5–80. It is worth pointing out that one of the males in this group lacked obvious skeletal evidence for violence as there was no damage to his cranium, but was doubtless killed at the same time as the other males. Other Cave 7 individuals with intact skulls very well may have been killed and interred at the same time as those who experienced cephalic brutalization.

The three burials for Group 2 that were dated by Coltrain et al. (2012) were also selected for redating (the infant placed on the chest of the adult was not sampled by Coltrain). The members of this group nearly encompass the full spread of the original date distribution and cannot be averaged, since they fail to pass the test for contemporaneity (df = 2, T = 11.6, χ^2 = 6.0, $\alpha = .05$) (Fig. 11). As with Group 1, however, all three of the NOSAMS dates exhibit substantial overlap of their distributions and pass the test for contemporaneity (df = 2, T = 3.2, χ^2 = 6.0, $\alpha = .05$). Again these dates support Wetherill's field observations and the corroborating photo documentation that the female and children were interred together at the same time. The average of the three NOSAMS assays provides the best estimate as to when this occurred: 1880 ± 17 BP, which has a 2σ calibrated date range of AD 70–215. The correspondence among the three NOSAMS dates and their consistency with the contextual evidence suggests they are more reliable and indicate that the previous date on Burial 408 is too old and that the previous date on burial 405 is too young. Note that there is negligible overlap between the average of Group 1 victims and the average of Group 2, and thus the new dates support the suggestion by Coltrain et al. (2012) that not all Basketmakers from Cave 7 were contemporaneous. The enhanced precision and statistical equivalence among the NOSAMS dates allows this detail to be teased out of the chronological soup.

For Group 3 (Fig. 12) the three Arizona dates actually pass the test for contemporaneity (df = 2, T = 4.2, χ^2 = 6.0, $\alpha = .05$), but this is mainly because the error terms for two of the assays are on the order of 60 years. If precision had been 40 years or less they would not be contemporaneous. The Arizona date for Burials 240 and 241 are nearly replicated by the NOSAMS assays, but the new dates have

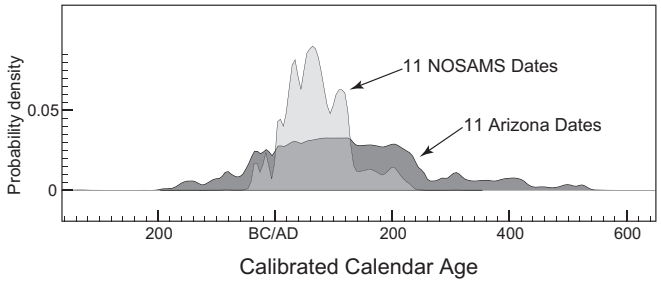

Fig. 9. The summed probability distributions for the NSF-Arizona and NOSAMS AMS radiocarbon dates on duplicate samples of the same purified collagen from 11 Cave 7 skeletons.

[8] The only true measure of accuracy with the radiocarbon technique is to date known age materials and this typically consists of dendro-dated wood samples. Results from the dating of four known age samples at the Fourth International Radiocarbon Inter-comparisons showed overall good agreement but "formal calculations showed that approximately 30% of the laboratories had a statistically significant offset" (Boaretto et al., 2003:151).

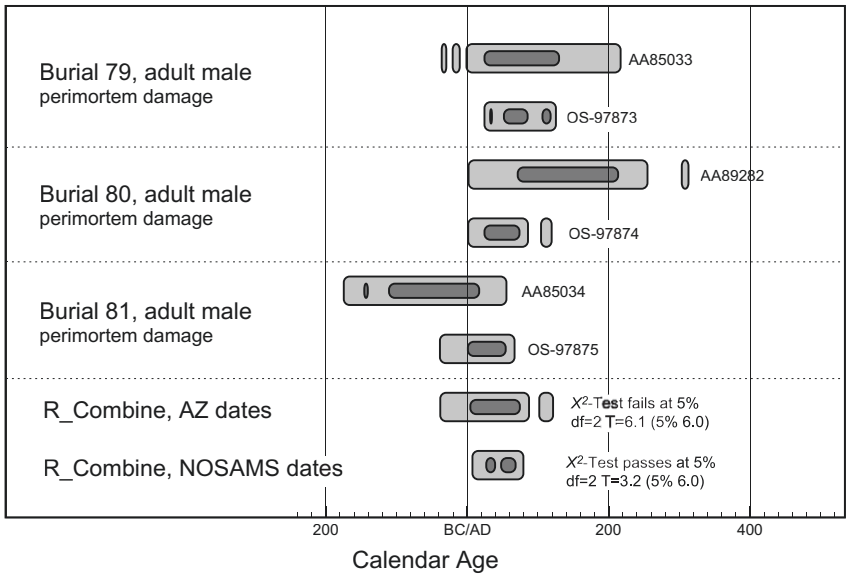

Fig. 10. Plot of calibrated 1σ and 2σ ranges for prior NSF-Arizona and new NOSAMS AMS radiocarbon dates for three of the Group 1 burials at Cave 7. Also shown are averages for each set of dates along with the results of χ^2 tests for contemporaneity.

reduced error terms. The Arizona date for Burial 244 is 120 radiocarbon years younger than the Arizona date for Burial 240, yet their distributions overlap because of the broad confidence intervals. The NOSAMS assay for Burial 244 does not corroborate the Arizona assay on this individual, being 120 years older. The three NOSAMS dates exhibit substantial overlap of their distributions despite small confidence intervals and pass the test for contemporaneity (df = 2, $T = 1.4$, $\chi^2 = 6.0$, $\alpha = .05$). The calibrated 2σ range of AD 1–80 for the average of these three dates (1964 ± 15 BP) is the best estimate of when this group was interred. This is virtually identical to the age for Group 1 based on the NOSAMS assays and like Group 1 it includes males that clearly died violently though some were not accorded special vicious treatment.

It is important to point out that the collagen sample for Burial 241 was processed twice at NOSAMS. The first result (1860 ± 25 BP, OS-97878) was significantly younger than the other two NOSAMS dates for Group 3 and failed to pass the χ^2 test at 5% (df = 2, $T = 14.3$, 5% = 6.0). A second analysis of the remaining portion of this sample returned a result in good agreement with the other two assays.

The Arizona dates for Group 4 are not overly dispersed, with just 90 radiocarbon years between the oldest and youngest ends of the range. Given the error terms of around 45 years it is permissible to pool the dates, resulting in an average of 1930 ± 27 (AD 5–130 at 2σ). Had the error terms been just 30 years they would have failed a test for contemporaneity. Still, the original results for this group seem to support Wetherill's observations, suggesting that the close and overlapping placement of the Group 4 skeletons derives from contemporaneous interment. To check this we redated burial 420, which has the youngest of the Arizona assays (1884 BP) for this group; the new date is just slightly older (1900 BP). The time of death for this group is perhaps best approximated by averaging all four assays, which is certainly permissible (df = 3, $T = 2.6$, $\chi^2 = 7.8$,

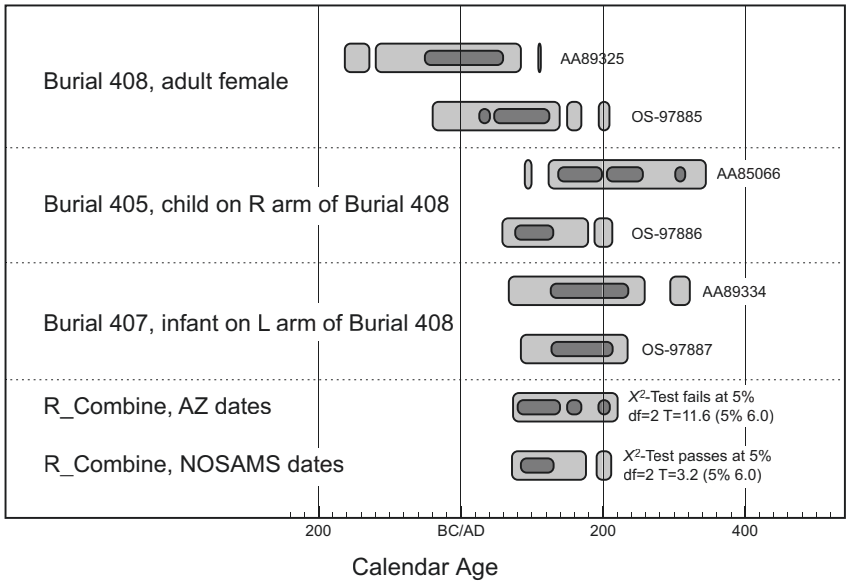

Fig. 11. Plot of calibrated 1σ and 2σ ranges for prior NSF-Arizona and new NOSAMS AMS radiocarbon dates for the Group 2 burials at Cave 7. Also shown are averages for each set of dates along with the results of χ^2 tests for contemporaneity.

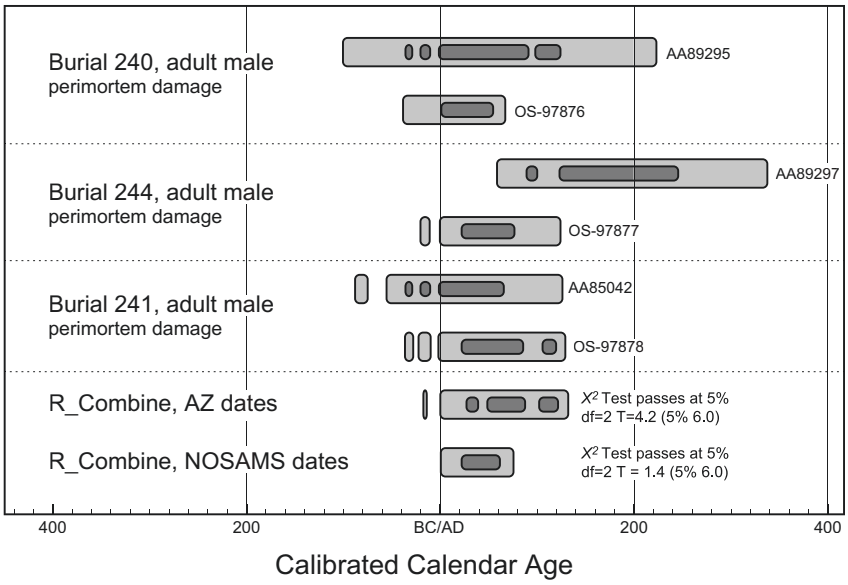

Fig. 12. Plot of calibrated 1σ and 2σ ranges for prior NSF-Arizona and new NOSAMS AMS radiocarbon dates for the Group 3 burials at Cave 7. Also shown are averages for each set of dates along with the results of χ^2 tests for contemporaneity.

$\alpha = .05$), resulting in a mean of 1914 ± 19 BP and a 2σ calibrated date range of 35–130 cal. AD. This group is distinctive from Groups 1 and 3 since it represents females and one infant and there is now good cause to say that some women and children (Group 2) were buried in Cave 7 after Groups 1 and 3. The date range for Group 4, however, overlaps considerably with those of Groups 1 and 3, such that these individuals may have been buried contemporaneously with those that died violently. The radiocarbon dates alone do not allow for a clear inference as to the interment sequence of Group 4, but, as we discuss below, the placement of these burials in Section 6 of the shelter raises the possibility that they represent a separate interment event after Groups 1 and 3.

The last date to consider is that on the ungrouped skeleton 322, which came from Section 1 of the cave. We redated this individual, since it is the youngest of the previous dates and exhibits such obvious and extreme perimortem cranial damage. This adult male skeleton is clearly one cornerstone of Coltrain et al.'s (2012) argument, since its age and the date for the equally brutalized Burial 81 of Group 1 are what allow them to claim that acts of violence were separated "by more than two centuries" (Coltrain et al., 2012:2223). The NOSAMS assay for Burial 322 is 1920 ± 25 BP (OS-97888), 270 radiocarbon years older than the previous date. Coltrain et al.'s date on Burial 322, just like the youngest of their assays for the skeletons of Groups 1 and 2, appear too recent and inconsistent with contextual data. Since Burials 81 and 322 have dates that are statistically indistinguishable, the acts of violence perpetrated on these individuals are not separated by more than two centuries; indeed, given the resolving power of the radiocarbon technique, the acts of bloodshed were contemporaneous. In such a case, the excavator's observations and interpretations must be accorded their proper interpretive weight. The massacre account cannot be overturned by the suite of radiocarbon assays reported by Coltrain et al. (2012).

5. The Cave 7 massacre reconsidered

The lack of contemporaneity in the Arizona dates for the groups just reviewed cannot be attributed to prehistoric disturbance, hasty excavation technique, or mixing in the museum, since the exact same purified collagen was dated by both radiocarbon labs. The NOSAMS samples consisted of the residual material after submission of samples to Arizona. It is clear that Coltrain's isolation and purification of the collagen is not at fault. Comparison of the dates for burial groups and individual skeletons indicates that some of the previous assays overestimate age whereas other assays underestimate age. These problems are not huge, indeed it is likely that many archaeologists would be pleased to have such dates, but in this situation every 100 years of discrepancy makes an important difference.

We trust by now that there is little need to belabor the point that the previous assays cannot be used to refute a single-event massacre to account for the skeletal assemblage recovered by Wetherill and fellow excavators. The possibility of dispersion in the original assays as a result of normal sampling error along with confidence terms that are nearly all ±45 years or greater makes them unsuitable for trying to determine whether a single interment event or multiple events are represented at Cave 7. The previous dates provide a general chronological bracket for the assemblage but they cannot serve to parcel it. Given the rather normal frequency distribution of the Arizona dates without clear clustering or multimodality, it is tempting to think of them as relatively imprecise estimates of a single event best represented by the approximate midpoint or mean. However, the NOSAMS dates are consistent with at least two interment events, since the slaughter victims of Groups 1 and 3 are older than the female with three children of Group 2. As such, an overall average of all 96 Arizona dates or all 11 recent dates is not justifiable. Excluding Group 2, the rest of the NOSAMS assays ($n = 8$), which are all in the 1900s BP, can be pooled (df = 7, $T = 10.5$, $X^2 = 14.1$, $\alpha = .05$), resulting in an average of 1949 ± 9 BP, yet whether this should be done is debatable since Group 4 might also represent a separate interment event. This possibility is not based on the radiocarbon results since they just hint at it, but with substantial overlap in the date distributions with Groups 1 and 3. Rather, it is the cave section that these individuals were placed within, their more typical, tightly flexed burial placement, and the sex and age (females and an infant) combined with a lack of obvious evidence of violent death.

A visual summary of the spatial patterning of important characteristics for the Cave 7 Basketmaker burials is shown in Fig. 13; we believe this information allows for basic parceling of the

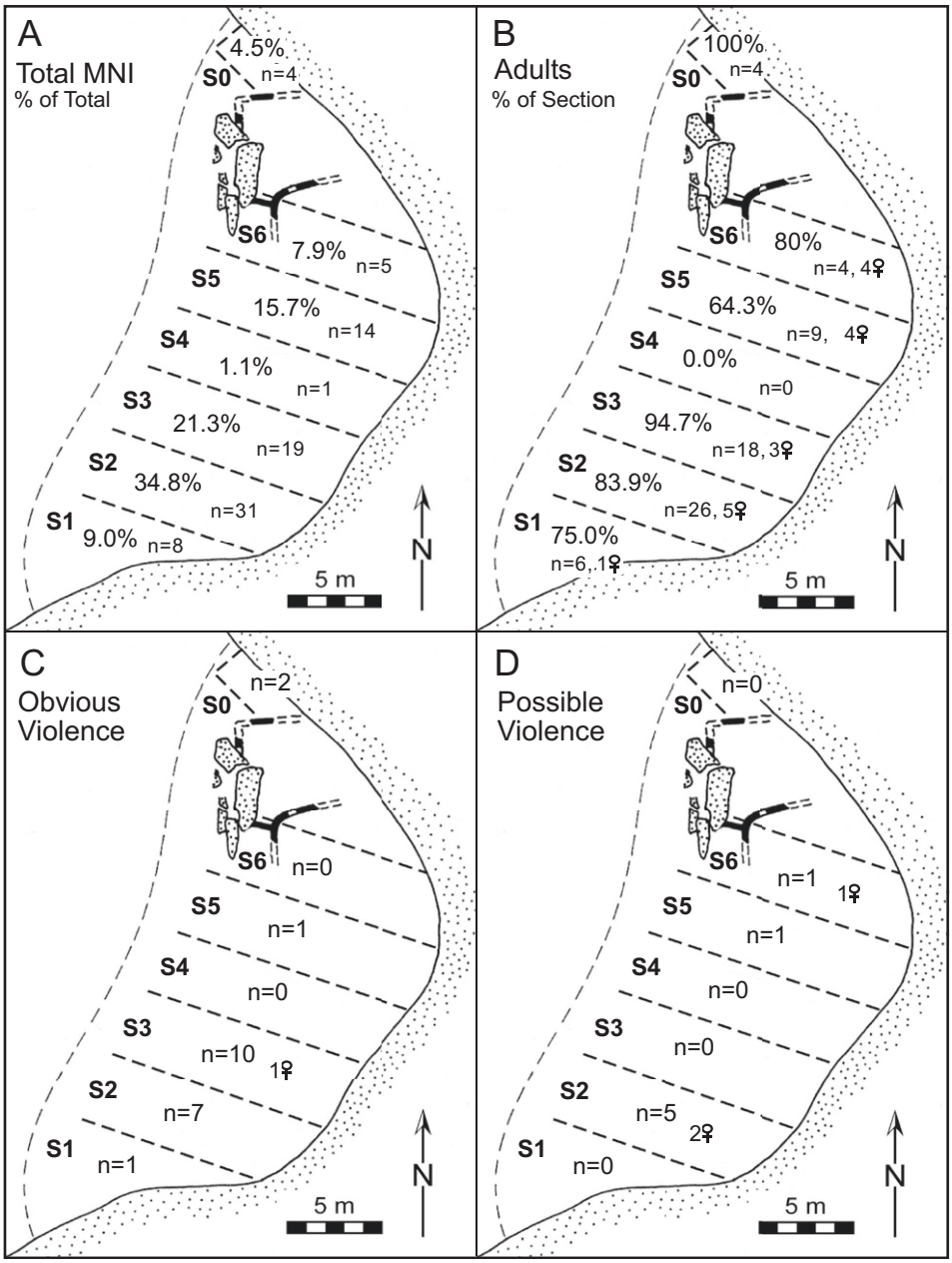

Fig. 13. Important characteristics of the Cave 7 Basketmaker II burial assemblage according to section of recovery: **A**, proportion (calculated overall) and count of individuals per section (total MNI = 89); **B**, proportion (calculated per section) and count of adults per section (total MNI = 70), with count of females indicated; **C**, count of skeletons per section exhibiting obvious evidence of violence (total MNI = 21), with the single female indicated; **D**, count of skeletons per section exhibiting possible evidence of violence (total MNI = 7), with the three females indicated.

assemblage. Sections 1–3 stand out because they not only yielded the majority of individuals (65%) but also almost all of the skeletons that exhibited obvious evidence of violent death (86%). The newly-redated males with perimortem damage came from Sections 1–3 (Groups 1 and 3 and Burial 322) as did the one female that obviously died violently (Burial 103), who came from Section 3 below the Group 1 males. Females were nonetheless poorly represented in Sections 1–3, with just nine (a male:female ratio of 3.9); children were also underrepresented, with just eight. Significant in the overall distribution is the near absence of remains from Section 4, just a single adolescent, despite the abundance of burials in the sections on either side, with 19 in Section 3 and 14 in Section 5. Coinciding with the gap in burials is an increase in the representation of females and children and vast decrease in obvious evidence for violent death. The Group 2 skeletons that were evidently interred sometime after the violently killed individuals of Sections 1–3, came from Section 5, which has the most "normal" death assemblage, consisting of equal numbers of males and females (3 each) and 36% children (see Table 1). Section 5 also has only one individual exhibiting obvious perimortem damage, a possible adolescent male 12–15 years of age (Hurst and Turner, 1993:186). The adjacent Section 6 had just 5 individuals—a child and four adult females, none of which exhibited obvious evidence of violent death; this includes the Group 4 burials.

Given the evidence just reviewed in conjunction with the new dates, we think the densely massed remains of Sections 1–3 represent a massacre assemblage interred at one time. This included males exhibiting obvious perimortem damage and

impaled with dart points (one female is also impaled) as well as males, females and children that do not exhibit such traces. Just because the women and children at the site lack the same sort of obvious perimortem damage as the males does not preclude them from victim status. Considering the number of interments in the limited space of Sections 1–3 of the small shelter, that included 50 adults, the individuals had to have been packed tightly together and overlapping, which is exactly what Wetherill's field record indicates. Accommodating this many individuals, along with the side-by-side placement of the eight Group 1 males, would have required a massive burial pit or a few very large pits. Numerous individual pits could not contain this population in the limited space available since doing so would have required contiguous excavations that would have amounted to a single large pit anyway.

The age for this massacre assemblage is best approximated by the NOSAMS assays for the burials of Groups 1 and 3 along with Burial 322, which can be pooled ($df = 6$, $T = 6.3$, $X^2 = 12.6$, $\alpha = .05$) resulting in an average of 1954 ± 9 BP, with a 2σ calibrated range of AD 20–80. The 3σ calibrated range of AD 1–115 provides a more cautious estimate, but there is vanishingly low probability of the event occurring after 90 AD given that 99.5% of the distribution is AD 1–85.

We know from the NOSAMS assays that the Group 2 individuals of Section 5 were probably interred in Cave 7 after the massacre assemblage, thus this northern portion of the shelter (Sections 5, 6 and 0) is a logical place to look for other post-massacre interments. Identifying additional interment events will require an expanded suite of accurate and precise assays like those reported here. However, as with Group 4 of Section 6, the temporal gap between the massacre and subsequent interments might be so short that it is undetectable with the radiocarbon technique. Continued use of Cave 7 as a burial place following the massacre makes sense for those family members that survived and the demographics of the massacre assemblage strongly indicate that women and children were taken captive, just like Hurst and Turner (1993:168, 171) suggested. Thus, one can envision wives or daughters of some of the slain men in Sections 1–3 comprising the Group 4 individuals. Continued use of Cave 7 as a family resting place also makes sense of the near absence of skeletons in Section 4—the general location of where the massacre victims were placed was doubtless known but perhaps not precisely so a buffer was allowed to prevent needless disturbance of prior burials.

As Fig. 13C shows, there are three obvious victims of violence in the northern portion of Cave 7; the previously discussed adolescent male in Section 5 (Burial 308) and two adult males in Section 0 (Burials 289 and 311). Redating of these individuals is called for in order to see whether these individuals postdate the massacre assemblage. The Arizona dates for two of these individuals (Burials 308 and 311) suggest that this might be the case since they are 100 radiocarbon years or more younger than the mean of the pooled dates for massacre assemblage. If verified, this would support Coltrain et al.'s suggestion that additional victims of violence were interred in the cave. If these individuals instead date to the interval of the overall massacre assemblage then it could mean that victims of the massacre were placed in more than one general place within the shelter. Burial 311 is significant in this regard since the head of this individual had been severely beaten much like those of the massacre assemblage (see Hurst and Turner, 1993:Figs. 8.28 and 8.29).

Regardless of how many other separate interments there were in the northern part of the shelter, it is evident that the bulk of the Cave 7 assemblage was interred at the same time and consisted of victims of a mass killing. These victims were largely adult males, many of whom were bludgeoned, but also included adult females and children. Knowing that Group 2 slightly postdates the massacre event further emphasizes the overall sex and age bias of the massacre assemblage at Cave 7—it is dominated by adult males with 35 represented in Sections 1–3 and perhaps more in the six unsexed adults that were present.

Given the fighting implements available during Basketmaker II (the one fire-type weapon was the atlatl and dart), the size of the group required to overpower 35 + healthy males, even with the advantage of surprise, was likely double or more the number killed. As Gat (1999:563) phrased it, "the principle of deadly violence in nature is fighting against weakness and fighting only at highly favorable odds—asymmetrical fighting." An attack with overwhelming superior numbers could easily have involved a coalition of at least twice the number of warriors killed, thus more than 60 and perhaps more than 80. Given that Basketmaker II farmers lived in scattered single family or small extended family homesteads (Dohm, 1994; Geib, 2011; Geib and Spurr, 2000; Smiley, 2002), the attacking force had to represent individuals from a sizable area. Even the Basketmaker II "neighborhoods" that Dohm (1994:272) recognized on Cedar Mesa consisted of just several dispersed households (ca. 4–5 in number), such that even if all residences were truly contemporaneous, they are unlikely to muster more than 10 adult males. Even the Rock Island site (NRc9-5), the largest documented Basketmaker II habitation in the region (which also happens to occupy a defensive location), contains five and perhaps as many as nine pithouses (Dohm, 1994; Matson, 1994; Matson and Brand, 1995). Matson (personal communications, 2012) sees this site as indicating the feasible maximum Basketmaker II community size on Cedar Mesa during an interval slightly later than the Cave 7 massacre (ca. AD 200–400). Even if the existence of nine contemporaneous households could be demonstrated for this site, it would have housed well below the number of males killed (probably fewer than half), to say nothing of the attacking force. The Cave 7 massacre assemblage therefore suggests collective action far beyond anything that archaeologists can infer at this time from all other evidence. It implies a form of social organization and cooperation, even if fleeting, that far exceeds in scale the social units of Basketmaker residential sites or even clusters of such sites.

6. Comparison of cave 7 and Crow Creek

In making their case that the Cave 7 assemblage was not a single massacre event, Coltrain et al. (2012:2227–2228) compare its skeletal assemblage with that from Crow Creek, South Dakota (e.g., Willey, 1990; Willey and Emerson, 1993). The gist of their argument is that since the Cave 7 assemblage lacks the sort of indiscriminate skeletal damage documented for Crow Creek (i.e., females and children had the same probability of being brutalized as did males), Cave 7 could not have been a massacre site. They acknowledge that the social and political context of the Crow Creek massacre differed markedly from that of Cave 7, but they cite that difference as further support against Cave 7 as a massacre assemblage. Since Crow Creek occurred in a context of greater social and political complexity, during times of higher population density with larger residential sites (true villages) and greater resource stress, these must be the factors necessary to generate a large scale massacre. Such social and ecological conditions were presumably absent during Basketmaker II, so there is an implicit doubt that intergroup conflict could result in the killing of numerous individuals. In other words, the scale of the killing is beyond what they would expect for food producers of comparatively simple social complexity and low-levels of resource stress. Space limitations do not allow us to address this important topic although we note in passing that ethnographic data indicate that the scale of the Cave 7 massacre assemblage is not without precedent for comparable social groups (e.g. Gat, 2006; Keeley, 1996; Kelly, 2000; van der Dennen, 1995).

With regard to the preferential application of brutal force in the Basketmaker case but indiscriminate use at Crow Creek, we suggest that the former seems to be a clear example of internal warfare as defined by Otterbein (1968, 1970) whereas the latter has all the signs of external warfare. In the Crow Creek case, the groups in conflict may well have come from distinct cultural/linguistic/ethnic traditions (Bamforth, 1994, 2006; Willey and Emerson, 1993), such that they might not have even recognized members of another group as fully human. In such a case, the victorious groups might not be bound by any social rules governing treatment of the vanquished dead and wounded. For internal war, however, cultural prescriptions might well constrain the violence meted out to the dead and dying of certain sex, age or other social categories. Consequently, we argue that the differences between Cave 7 and Crow Creek say nothing about whether or not a massacre occurred at Cave 7, though they may tell us something about the relationship between the battling groups.

Dates always must be assessed in relation to what we know about context even if that knowledge is less than ideal, as it most always is when working with old collections. No dates were obtained on the massive Crow Creek skeletal assemblage (minimally 486 people), but if this had occurred, simple sampling error easily could have resulted in a suite of radiocarbon determinations as dispersed as those for Cave 7. Nonetheless, it seems unlikely that such results would justify arguing for multiple interments of massacre victims at Crow Creek because the more meticulous excavation and documentation techniques of the late 1970s make the excavators' attribution of a single-event massacre as the cause for the skeletal assemblage more acceptable even if the dates themselves suggest otherwise. Coltrain et al. (2012) minimized the importance of the contextual data in their assessment of the Cave 7 dates, despite Wetherill's excavation notes and photo documentation strongly suggesting they had a "messy" suite of radiocarbon assays. Although Wetherill's records for Cave 7 are not comparable to modern standards, they nonetheless are indispensible for maximizing the information potential of the site.

7. Conclusions

Claims for massacres or similar atrocities justifiably require critical scrutiny and verification, but the radiocarbon technique has limits in resolving power that must be acknowledged. Dates with narrow confidence intervals and that appear accurate based on internal evaluative criteria, such as constancy among probable groupings or reproducibility of radiocarbon measurements on the same sample can only go so far. The error terms of individual dates combined with a need for calibration virtually precludes conclusive demonstration that a group of individuals formed a single death assemblage instead of accumulating across decades. Such a determination is beyond the limits of resolution of the radiocarbon method and must be based on excavation context and observations made while exposing the remains, with direct dates serving to place them in time and helping to corroborate judgments about the relative ordering of events. New techniques might eventually be developed that can allow stronger inferences in cases where the field record is less than ideal, as is the case here, but the current set of radiocarbon dates need to be interpreted in conjunction with field notes, photos and observations by the excavators, rather than treated as the ultimate arbiter.

In the case of Cave 7, the NOSAMS assays reported here prove that the radiocarbon dates of Coltrain et al. (2012) cannot be used to overturn Wetherill's massacre interpretation. Some of their assays are either too old or too young by a century or more and they lack sufficient precision to separate burial events closely spaced in time. The more recent set of internally consistent and more precise dates combined with the information of burial context strongly suggests that Cave 7 contains the remains of several interment events with one of these consisting of a massacre assemblage. It is smaller in scale than Richard Wetherill thought in the late 1800s or that Hurst and Turner argued for in 1993. The number of massacre victims at Cave 7 is less than what Wetherill thought because the NOSAMS dates confirm that at least one set of skeletons (Group 2) were interred in Cave 7 after the massacre. Information on burial treatment, demographics, and placement in the shelter suggest that this is also likely for many of the other skeletons recovered from outside the area that contained the massacre assemblage (burials outside of Sections 1–3). Radiocarbon dating might not allow interment events to be statistically distinguished, as with the females and infant of Group 4, something that may never be achieved for burials that occurred soon after the massacre. Continued use of Cave 7 for mortuary purposes after the massacre is certainly worth evaluating with additional dating and a good starting place would be the males of Sections 0 and 5 that exhibit obvious signs of violent death.

Despite the evidence that multiple interment events formed the Basketmaker II burial assemblage at Cave 7, massacre victims comprised the bulk of the skeletal remains, around 58 individuals, including 35 adult males. The skeletons were grouped together in both somewhat formal layouts and haphazard heaps in the southern part of the shelter. The number of individuals killed, especially the tally of males, implies an attacking force of considerable size and thus the ability to mobilize a coalition of unprecedented scale for this early time period in the Southwest. The social scale represented by this military force is subsequently visible in the settlements of the Southwest several hundred years later (e.g., Wilshusen et al., 2012) but not during the Basketmaker II period, when settlements are small and scattered. The nature of intergroup conflict represented at Cave 7 could well have been an important incentive for people to negotiate arrangements that facilitated larger and more integrated social forms; such intergroup violence also could have worked as a selective "force" to ensure the perpetuation and elaboration of these forms.

This paper is ultimately about the social scale of violence among pre-pottery farming groups of the Southwest but it hinges upon the interpretation of radiocarbon dates. One reviewer commented that, despite our emphasis on chronology, we had not dealt with the "elephant in the room—apparently unreliable radiocarbon dates." We are well aware that such an elephant exists since the reported results of international radiocarbon laboratory intercomparisons have shown that "…30% of the laboratories had a statistically significant offset" for the dating of known age samples (Boaretto et al., 2003:151) and that "a total of 122 observations out of 1056 (i.e. slightly over 10%) was identified as anomalous (i.e. outliers)" (Boaretto et al., 2003:149). The most recent intercomparison (VIRI) was split into phases with the second involving bone samples, including those of known age; again significant outliers occurred: "Up to 12% of the results for any 1 sample were identified as outliers…" (Scott et al., 2010:854). A recent study of dates on different materials from a finely-stratified and well excavated site in Alaska showed that "even within a robust concordant suite of feature dates within highly resolved archaeological contexts, radiocarbon variability can occur" (Potter and Reuther, 2012). It is this knowledge and personal experience with other confounding suites of dates that spurred us to try and verify the assays of Coltrain et al. using an independent radiocarbon lab, especially for those burials that should have been contemporaneous based on contextual groupings. One's perception of date reliability clearly depends on the degree of chronological resolution demanded for a particular research problem. In this instance we are dealing with an issue that requires a temporal resolution of less than a century. In such a case, even small counting errors or traces of contamination have

important consequences. Radiocarbon labs are constantly trying to improve the accuracy and precision of reported results, hence their emphasis on quality control to achieve the highest standards of quality assurance. This is all well and good but as the end users of dating results archaeologists must be savvy consumers since important interpretations of prehistory turn on the numbers generated.

Acknowledgments

We thank Bill Lipe, RG Matson, Steve Plog, Steven LeBlanc and Pat Lambert reviewers for helpful comments on an earlier draft. We are very grateful to Joan Coltrain for providing the residual collagen that we redated. The senior author has received support from the Department of Anthropology and the Maxwell Museum of Anthropology at the University of New Mexico (especially the Hibben Doctoral Research Award and the Ethel Jane Westfeldt Bunting Fellowship), the National Science Foundation (Grant 1025643), and the Graduate and Professional Student Association at UNM and wishes to acknowledge the help of Bruce Huckell, David Phillips and Ann Ramenofsky.

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