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THE SOCIAL IMPLICATIONS OF BASKETMAKER II CORDAGE DESIGN DISTRIBUTION

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ABSTRACT

Exceptionally preserved cordage artifacts from Basketmaker II sites offer a rare insight into social processes that persisted during the 1500-year beginnings of agricultural lifeways and village sedentism on the Colorado Plateau. Through an analysis of cordage design, I examine the process of knowledge sharing among Basketmaker II peoples. I propose that certain technical choices in raw-material selection and fiber-twisting methods result from an artisan's enculturative knowledge and experience alone, and that spatial clustering indexes pools of shared knowledge among artisans. Data describing formal variation in Basketmaker II and non-Basketmaker II cordage show that, with respect to raw material and twist structure, Basketmaker II cordage is internally consistent but significantly different from non-Basketmaker II cordage. I propose that the observed patterns in Basketmaker II cordage design index the geographical extent of a pool of shared knowledge that circulated within a clinally-unified Basketmaker II marriage network.

RESUMEN

Artefactos del cordaje excepcionalmente bien preservados de los sitios de Basketmaker II ofrecen una perspicacia rara a los procesos sociales que persistieron durante los 1500 anõs en que nació la vida agrícola y sedentaria en la meseta de Colorado. Con un análisis del diseño del cordaje, examino el proceso del compartimiento de conocimiento entre el pueblo de Basketmaker II. Propongo que ciertas opciones técnicas en la selección de la materia prima y los métodos de torcer la fibra resultan del conocimiento enculturativo y la propia experiencia de un artesano y que índices de agrupación espacial marcan conocimientos compartidos entre artesanos. Datos que describen la variación formal del cordaje en Basketmaker II y en el período no Basketmaker II en cuanto a materia prima y la estructura de la torcedura muestran que el cordaje de Basketmaker II es internamente constante pero significativamente diferente del cordaje del período no Basketmaker II. Propongo que los patrones observados en el diseño del cordaje de Basketmaker II proveen un índice del alcance geográfico de una fuente de conocimientos compartidos que circuló dentro de una red matrimonial espacialmente unificada de Basketmaker II.

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Although the timing and duration of the U.S. Southwest's agricultural revolution is coming increasingly into focus, the social nature of the transition remains relatively open to interpretation. Approximately 3500 years ago, peoples of the Southwest rapidly and intensively incorporated cultigens into their subsistence economies (Huckell 1996; Matson 1991; Matson and Chisholm 1991; Smiley 1997a; Wills 1995). Despite the adoption of agricultural pursuits, which can stifle more mobile economic pursuits, early agriculturalists were slow to transition to settled village life. Accordingly, archaeologists must account for approximately 1500 years of social process that operated between agricultural adoption and village sedentism (Smiley 1997a:39; see also Smith 2001).

In and around the San Juan drainage, the Early Agricultural Period is manifest in Basketmaker II culture. Basketmaker II archaeologists have explored various components of Basketmaker II social processes (Matson 1991, 1999; Robins 1997; Webster and Hays-Gilpin 1994). In this paper, I draw upon Early Agricultural Period cordage data to infer the inclusiveness of Basketmaker II enculturative processes. I argue that technical choices in certain raw-material procurement and fiber-twisting activities index an artisan's enculturative background (Clark 2001). In turn, spatial and quantitative clustering of the resultant cordage-design states index the extent and relative intensity of enculturation pools.

Accordingly, I analyze the raw materials and twist structures of cordage from eight Basketmaker II assemblages in order to infer the extent of shared enculturative knowledge among Basketmaker II peoples. The data show that Basketmaker II cordage is relatively homogeneous. Non-Basketmaker II cordage differs significantly from Basketmaker II cordage, indicating that although the Basketmaker II cordage is internally consistent, it also appears to be spatially and temporally bounded. The observed patterns in Early Agricultural Period cordage imply that Basketmaker II peoples participated in an enculturation pool that spanned the known geographic extent of the Basketmaker II universe. I propose that a clinally unified marriage network served as the mechanism for diffusing knowledge of cordage-producing behaviors.

THE CASE FOR CORDAGE: INTERPRETING DESIGN VARIATION

Analysts often correlate certain cordage design attributes with passive learning behavior, or enculturation (Carr and Maslowski 1995; Clark 2001; Maslowski 1996; McBrinn 2002, 2005; Minar 2000; Newton 1974). It seems reasonable to expect, then, that such design attributes in Basketmaker II cordage would index shared knowledge among the early agricultural artisans. In this section, I place the processes of cordage production in a behavioral framework (Schiffer 1996; Schiffer and Skibo 1997) in order to deduce a set of behavioral implications for Basketmaker II cordage-design variation. I outline potential cordage manufacturing activities and correlate the technical choices with formal properties. Theoretical arguments, experimental data, and ethnographic observations are used to link the formal properties to potential performance characteristics, which are expected to weight an artisan's technical choices. Technical choices that impart no readily apparent performance advantage over other options are identified as potential indices of an artisan's enculturative knowledge or experience alone. In turn, spatial, quantitative, and relational patterns in certain cordage attributes index pools of shared enculturative knowledge and experience, or enculturation pools.

CORDAGE DESIGN

Space does not allow me to consider all of the myriad behaviors that result in functional cordage. Rather, I summarize some situational factors and performance characteristics (Schiffer and Skibo 1997:31–39) that are likely to affect technical choices in raw-material processing and fiber twisting prehistorically on the Colorado Plateau.

RAW MATERIALS

To produce cordage, an artisan must first locate and collect raw materials that meet primary performance thresholds in flexibility and tensility. The Colorado Plateau offers a suite of botanical, faunal, and mineral materials for the production of cordage (Bell and King 1944; Buchanan 1985; Haas 2001:170–174, 2003:64–76; Kent 1983; Osborne 1965), but none of the materials offers a perfect solution for all cordage functions. Prehistoric artisans had to navigate a series of procurement and processing activities to arrive at a "best-fit" material for a task or set of tasks (Schiffer and Skibo 1997:41–42).

The leaf fibers of yucca *(Yucca spp.)* and the bast fibers of some herbaceous plants offer superior tensility compared to other botanical fibers (Nyrges 1999). Yuccas are spatially and temporally ubiquitous on the Colorado Plateau (Haas 2003:54–57; U.S.D.A 2005) and could have furnished prehistoric peoples with ample cordage-making material. From availability and performance perspectives, two categories of yucca plants—broadleaf and narrowleaf yuccas—may present equifinal alternatives (Haas 2003:54). Both are found throughout the Colorado Plateau and are processed similarly. The leaves are prepared and scraped to expose stiff green to yellow fibers,[1] but finer-textured yucca fibers may be obtained by chewing the extracted fibers (Bandelier in Robbins et al. 1916; Haas 2001:179–181; Kent 1983:17–44; Kluckhohn et al. 1971:230; Osborne 1965) or selecting younger leaves from the yucca plant (Osborne 1965:45). The resultant fibers are relatively white and soft.

The bast fibers of apocynum (*Apocynum spp.*) and some milkweeds (*Asclepias spp.*)[2] exhibit tensility (Nyrges 1999), flexibility, texture, and color that is comparable to fine-textured yucca fibers (Kent 1983:20). The fiber-bearing bast stems may be gathered perennially but are optimally collected in late summer or fall. Apocynum and milkweed occur throughout the U.S. Southwest in higher elevations and riparian areas (Haas 2003:57–60). Where stands of relatively tall bast plants are available, prehistoric artisans could have obtained significant quantities of fibers (Adovasio 1986; Kent 1983:17–44; Leeds 1999; Wheat 1967:55–59). Accordingly, four classes of fibers—broadleaf yucca, narrowleaf yucca, apocynum, and milkweed—present apparently equally viable fiber solutions for producing cordage on the Colorado Plateau. These classes appear to be equally available (at least as concerns relatively mobile farmer-collectors) and appear to present mechanically and visually comparable solutions to cordage manufacture.

FIBER TWISTING

An artisan can manipulate the tensility, length, flexibility, and/or diameter of a cord by agglomerating and twisting fibers into cordage (Emery 1952). Twisting, as I use the term here, encompasses the mechanical processes of spinning and plying fiber yarns. Most prehistoric North American cordage consists of two plies because of mechanical-performance and energy-expenditure considerations (Hoover 1974). Two plies are a minimum requirement for plied cordage. Cordage of more than two plies requires greater dexterity and/or more manufacturing steps to produce and does not impart a significant performance advantage unless more strength is required. An artisan can more easily achieve greater tensile strength by choosing a stronger material, increasing the number of fibers per ply, or re-plying cordage. Re-plying is the process of plying two or more pieces of cordage (Emery 1966).

A number of cordage-twisting methods were available to Archaic and Early Agricultural peoples of the Southwest. Barring the use of the spindle whorl, ethnographic accounts indicate that non-industrial peoples of the Southwest practiced thigh-rolling (Kluckhohn et al. 1971:230; Wheat 1967:58–59) and shin-rolling (Campbell 1999:135; Michelsen 1966:44) methods of spinning and plying cordage. Although shin- and thigh-rolling activities can be combined in many ways to produce cordage, only four different structural states are possible: (1) s-spun, Z-plied; (2) z-spun, S-plied; (3) s-spun, S-plied; and (4) z-spun, Z-plied (Figure 1). The former two outcomes, termed cable-laid, are weighted for structural durability and ease of construction (Osborne and Osborne 1965:1100). Comparison of the two cable-laid options reveals no apparent mechanical advantage, and the properties of a given fiber material appear to impart no significant rotational preference on the fibers (Peterson and McBrinn 2002; see also McBrinn and Smith, this issue).

Perhaps the only reason for consciously choosing between z-spun, S-plied and s-spun, Z-plied cordage is to serve a visual function. The low absolute and

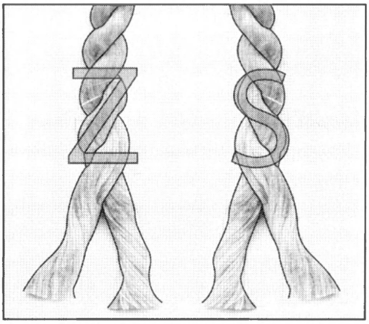

FIGURE 1. Two-plied cordage. The example on the left is s-spun, Z-plied (2s-Z) cordage, the example on the right z-spun, S-plied (2z-S).

relative physical visibilities (Carr 1995) of the twist structures suggest little potential for the participation of cordage in long range, intergroup social messaging, but cordage twisting and cordage would have been relatively visible in repetitive, short range, household interactions. Such contextual visibility offers the opportunity for artisans to imbue twisting activities and the formal results with ideological meaning (Minar 2000:98).

The low absolute visibility of cordage twist implies that knowledge of cordage-producing activities and cognition of form is most likely to be transmitted through relatively intimate person–person and person–artifact interactions. In band-level societies, such close and long-duration interactions occur within a household or band (Clark 2001; McBrinn 2002, 2005). The learned behavior of fiber twisting or the cognition of cordage twist would have been consciously or unconsciously transmitted by a teacher and passively received by a student (Carr 1995:184).

In summary, four general material choices and two twisting configurations present practically the same mechanical alternatives to cordage production on the Colorado Plateau. Consideration of situational factors (e.g., environmental or technical constraints) reveals no readily apparent advantage among the material alternatives. Similarly, two twisting strategies offer apparently equifinal performance alternatives, with the caveat that short range, visual performances could influence the technical choice of twist direction. Regardless of whether or not twist direction was cognized, the same mechanism, enculturation, is likely to influence cordage-twisting behaviors.

SPATIAL, RELATIONAL, AND QUANTITATIVE VARIATION

If certain technical choices in cordage design can be attributed to an artisan's enculturative background, then it follows that spatial and quantitative patterning in corollary design attributes would index the presence and relative intensity of enculturative behaviors, or enculturation pools, at a given activity area at a given time. Some potential implications for variations in the spatial, relational, and quantitative dimensions (Rathje and Schiffer 1982) of archaeological cordage are described below. I infer from relationships between archaeological cordage, cordage-related artifacts, and cordage-manufacturing byproducts and tools that the spatial location of a given piece of Basketmaker II cordage in an archaeological context generally correlates to the spatial location of cordage manufacture in the systemic context. That is, Basketmaker II cordage was generally manufactured by Basketmaker II peoples and was not imported from other cultural contexts. In turn, for a given cordage population, the proportions of cordage types (as defined by certain materials and twist sequences) is primarily a function of the relative intensity of enculturative practices present in that cultural system.

Basketmaker II cordage-related artifacts show that cordage served a number of functions from lashing bundles of basketry withes to stitching leather and constructing rabbit nets (Geib et al. 1999; Guernsey and Kidder 1921; Kidder and Guernsey 1919, 1922; Lindsay et al. 1968; Lockett and Hargrave 1953; Morris and Burgh 1954; Schilz 1979; Smiley and Parry 2001). Such activities suggest that the majority of cordage in Basketmaker II society appears to have participated in relatively mundane household and subsistence activities (see Clark 2001). Cordage also participated, however, in more technologically complex or ceremonial artifacts (e.g., cloth, fur, and feather blankets, or pahoes). Because such items are potentially subject to trade or manufacturing specialization, they have the potential to introduce sampling bias into a cordage assemblage by skewing artifact counts in favor of individuals or introducing cordage from other enculturative contexts. As long as the more mundane artifacts can reasonably be culled from an assemblage, I expect the cordage attributes to uniformly reflect the cordage-manufacturing behaviors of the site's inhabitants.

The coincidence of cordage, cordage-manufacturing byproducts, and cordage-manufacturing tools further serves to identify the likelihood that an artisan manufactured cordage in the same spatial context as cordage deposition. For example, the presence of yucca-fiber masses in association with yucca-fiber cordage at Boomerang Shelter suggests that the manufacture and deposition of yucca-fiber cordage occurred at the same site (Haas 2001). Similarly, notched scapulae and ribs, which are inferred to have been used in yucca fiber-extraction activities (Jones and Fonner 1954:99; Morris and Burgh 1954:61–62), are found in association with cordage at the Durango Rockshelters (also known as the Falls Creek Rockshelters). Such associations suggest that Basketmaker II artisans produced and discarded yucca-fiber cordage in the same spatial context.

Although it is probable that some portion of cordage from a given site entered from other enculturative contexts, it seems likely from relational evidence that the majority of cordage artifacts were discarded in the same enculturative context, if not the same site context, as cordage use and production. Given adequate stratagraphic control, relational control, and sample sizes, the quantitative dimension of artifact variability for a given assemblage should reveal gross trends in local cordage-producing behaviors. Fortunately, Basketmaker II cordage from rockshelter contexts often exists in sufficiently large quantities to warrant statistically robust conclusions about cordage populations.

DELINEATING BASKETMAKER II ENCULTURATION BOUNDARIES

The previous sections suggest that certain design choices in raw-material selection and fiber twisting may produce attributes that do not necessarily affect the mechanical qualities of cordage. Instead, formal variation is a function of an artisan's enculturative background, and patterning in the distribution of formal variation is a function of shared enculturative knowledge among artisans. The methods outlined herein serve a) to describe formal variation in cordage materials and twist structure and b) to derive, to the extent possible, a representative sample of Basketmaker II cordage.

MEASURING FORMAL CORDAGE VARIATION

Basketmaker II assemblages offer a rare opportunity in archaeology to observe many formal attributes in archaeological cordage (see Carr 1995:157–158). In this study, I describe cordage material and twist structure. To identify cordage materials, I assembled a comparative collection of seven potential Colorado Plateau botanical fiber sources and examined the fibers using scanning-electron and transmission-light microscopy techniques (Haas 2003:64–76). Following the polythetic fiber identification system developed by Jakes and colleagues (Jakes 2000; Jakes et al. 1993), and incorporating Bell and King's (1944) methods of yucca- and agave-fiber identification, I developed a classification system that allows the confident identification of broadleaf yucca, narrowleaf yucca, and bast fibers. Unfortunately, the fiber identification methods do not allow for discrimination between apocynum and milkweed fibers, which are combined under the term bast.

Researchers have devised numerous conventions for describing cordage structure (Emery 1952, 1966; Osborne and Osborne 1954; Hurley 1979; Wendrich 1991). Because cordage terms often present a source of confusion, and the use of different terms has generated ambiguous information (Amsden 1930; Emery 1952; Haas 2003:88–90; Hurley 1979:7), I explicitly describe the terminological system employed in this paper. The spin direction of a yarn is denoted by a lowercase letter and the ply direction by an uppercase letter (Emery 1966). Given a vertically oriented cord, the letter s describes a twist direction that slants from upper left to lower right and the letter z from upper right to lower left (Figure 1). The number of plies precedes the lowercase letter, and a dash separates the spin designation from the ply designation. The final or highest level of twist is

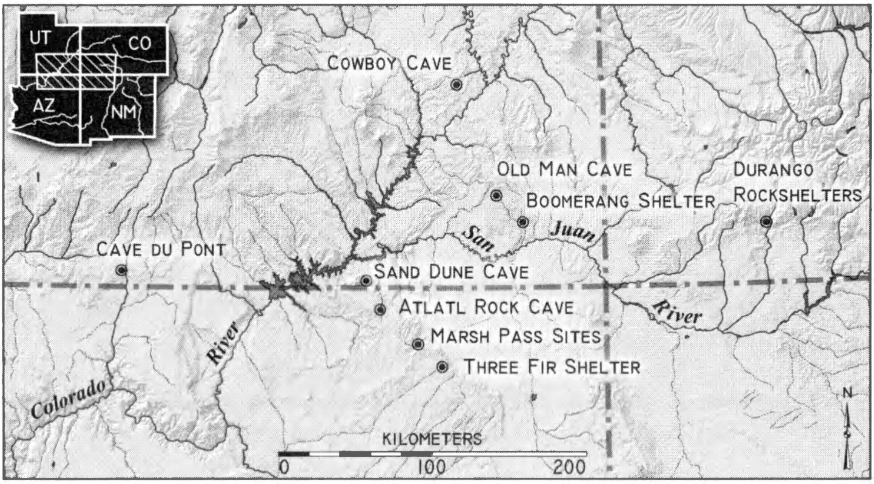

FIGURE 2. Sites with cordage assemblages analyzed or discussed in this study.

placed to the far right and the first or lowest level of twist in the sequence to the far left. Therefore, a piece of cordage in which three yarns are s-spun and Z-plied is expressed as 3s-Z. In the case of re-plied cordage, earlier constructions are set in parentheses. For example, the cordage produced by two pieces of 3s-Z cordage that are re-plied S-wise is expressed as 2(3s-Z)S.

REGIONAL SAMPLING

At the regional level, I examined artifacts from Basketmaker II sites in and around the San Juan River drainage (Figure 2). For comparative purposes, I also examined cordage from a selection of spatially or temporally adjacent non-Basketmaker II sites. Despite exceptional preservation, Basketmaker II cordage is not uniformly distributed across the known Basketmaker II universe. Basketmaker II cordage is confined to dry rockshelters, which are unevenly dispersed across the landscape. The patchy distribution of cordage prevents any possibility of a uniform sample distribution. Moreover, the widespread distribution of Basketmaker II collections in museums from Los Angeles to New York also limited my ability to achieve a uniform regional sample population. To the extent possible, I mitigated such spatial shortcomings by personally analyzing readily available collections and supplementing the dataset with published data.

I personally examined a sample of cordage artifacts from four Basketmaker II assemblages: Atlatl Rock Cave (Geib et al. 1999), Boomerang Shelter (Smiley and Robins 1997), Old Man Cave (Geib and Davidson 1994), and Three Fir Shelter (Smiley and Parry 2001). Publications for the Durango Rockshelters (Morris

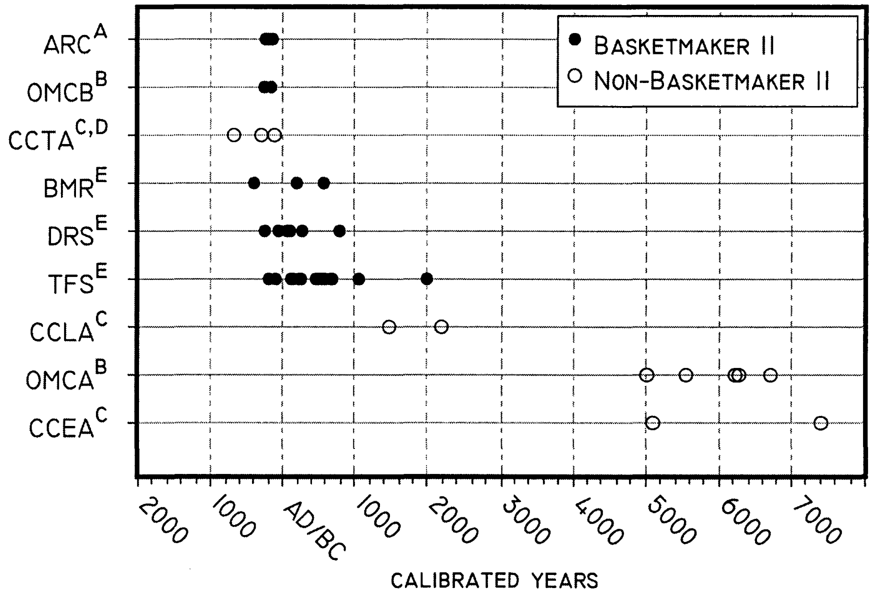

FIGURE 3. The temporal distribution of site components as shown by calibrated midpoints of 14C two-sigma ranges. Key: ARC= Atlatl Rock Cave; BMR=Boomerang Shelter; CCEA=Cowboy Cave, Early Archaic component; CCLA=Cowboy Cave, Late Archaic component; CCTA=Cowboy Cave Terminal Archaic; DRS=Durango Rockshelters; OMCA=Old Man Cave, Early Archaic component; OMCB=Old Man Cave, Basketmaker II component; TFS=Three Fir Shelter. Data sources: [A]Geib et al. (1999), [B]Geib and Davidson (1994), [C]Shroedl and Coulam (1994); [D]Geib (1996), [E]Smiley (1997a).

and Burgh 1954; Peterson and McBrinn 2002), the Marsh Pass sites (Guernsey and Kidder 1921; Kidder and Guernsey 1919), Cave du Pont (Nusbaum 1922), the Desha Caves (Schilz 1979), and Sand Dune Cave (Lindsay et al. 1969) provided supplemental cordage data.

The unfortunate result of this regional sampling strategy is that the samples cluster in approximately the central third of the San Juan drainage. Although the spatial distribution of cordage-containing Basketmaker II sites is less than optimal, the distribution of artifacts suffices for this study. The sites cover a maximum geographic extent of approximately 415 kilometers from the Durango Rockshelters in southwestern Colorado to Cave du Pont in south-central Utah. The inclusion of a vast geographic extent is necessary to resolve potentially subtle clinal variation in the population proportions of artifact types. Similarly, the unequivocal Basketmaker II data extend over a large temporal range (Figure 3). The time depth is primarily a function of the temporal resolution of the assemblages, but allows for limited evaluation of design constancy throughout the Basketmaker II period.

SITE SAMPLING

Each site in this analysis presents a different set of sampling problems. To the extent possible, I examined a sample that represents site-wide trends in cordage form. I randomly sampled (with replacement) 30 artifacts[3] from each dated stratigraphic unit. Although the extent of the original excavation and collection strategies constrained sampling, the sampling strategy attempted random coverage of the cultural deposits of interest. Care was taken, to the extent possible, to select discrete cordage fragments that reasonably appeared not to have come from a single artifact (see Custer 2004). Care was also taken to target cordage fragments that were likely to have been manufactured in the same enculturative context as deposition. Because cordage that appeared to be part of more elaborate artifacts might have entered a given site from other enculturative contexts, such samples were rejected.[4] For example, cordage that showed evidence of fur or feather wrappings was rejected because fur and feather blankets are technologically complex items subject to specialization and trade.

CORDAGE OF THE BASKETMAKER II PEOPLES AND BEYOND

The total sample of cordage evidences differences between the population proportions of Basketmaker II and non-Basketmaker II assemblages, but relative consistency within the respective assemblages. All of the Basketmaker II cordage assemblages are dominated by 2s-Z yucca-fiber cordage and the non-Basketmaker II sites by 2z-S bast-fiber cordage and 2s-Z cordage of various coarse fibers (Figure 4).

BASKETMAKER II CORDAGE

Of the 131 Basketmaker II cordage samples analyzed in the study, 97 percent are manufactured from yucca fibers (Table 1). Of the 69 pieces of yucca fiber cordage that could be identified to the broadleaf/narrowleaf level, 77 percent are of the broadleaf yucca variety and 23 percent are of the narrowleaf variety. The four Basketmaker II sites that produced identifiable broadleaf and narrowleaf yucca fibers suggest strong (though woefully insignificant) similarities in the proportions of broadleaf yucca, narrowleaf yucca, and bast fiber cordage (χ^2=3.218, p=.359, V=.216). If the yucca types are aggregated (in order to increase the sample size by including those samples that could not be identified at the level of broadleaf or narrowleaf) and compared in proportion to the occurrence of bast fibers, the data evidence significantly strong similarities in the population proportions of fiber types (χ^2=24.183, p=.002, V=.304; Figure 5).

As with raw material variation, cordage twist structure is relatively consistent in Basketmaker II assemblages (Table 2). Published literature allows for an expanded dataset on twist sequence. Of the 383 Basketmaker II samples, 81 percent are 2s-Z constructions. 2z-S twist structures account for 12 percent of the

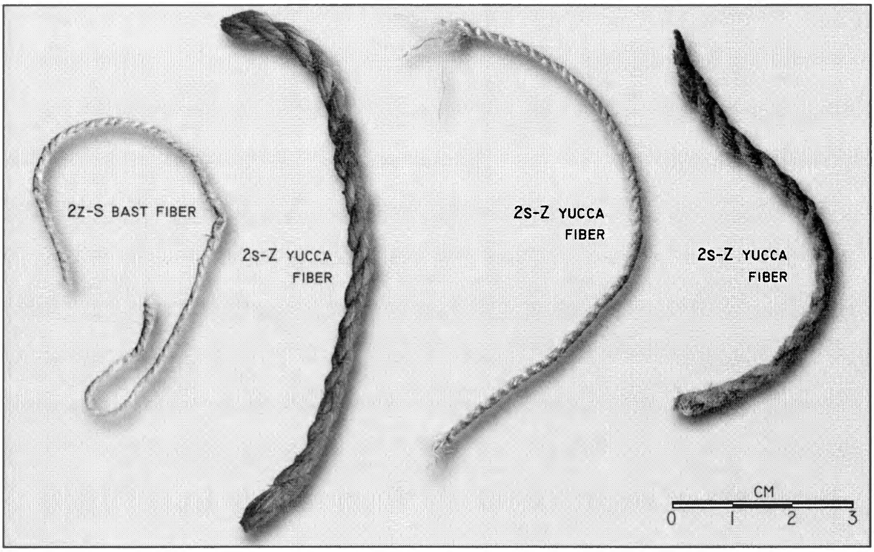

FIGURE 4. Representative non-Basketmaker II (left two) and Basketmaker II (right two) cordage from Cowboy Cave and Boomerang Shelter, respectively.

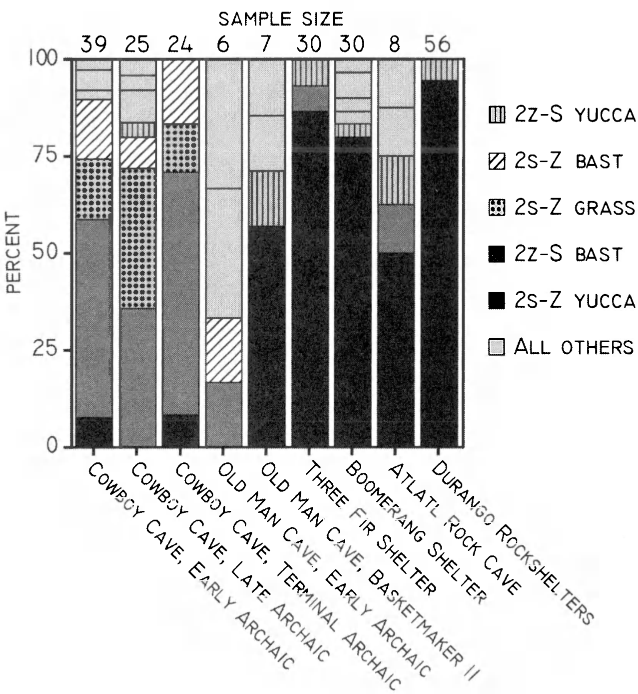

FIGURE 5. Proportions of all cordage types in assemblage samples.

TABLE 1. Cordage materials by assemblage.

	Basketmaker II						Non-Basketmaker II				
	ARC	BMR	DRS[a]	OMCB	TFS	n	OMCA	CCEA	CCLA	CCTA	n
bast	13%	—	—	—	7%	3	33%	72%	44%	79%	60
bark	—	—	—	—	—	0	33%	3%	4%	—	4
broad-leaf yucca	38%	83%	—	57%	70%	53	17%	3%	4%	—	3
narrow-leaf yucca	38%	17%	—	14%	23%	16	—	3%	8%	4%	4
indeterminate yucca	—	—	100%	29%	—	58	17%	5%	—	4%	4
grass	—	—	—	—	—	0	—	15%	36%	13%	18
hair	13%	—	—	—	—	1	—	—	—	—	0
sinew	—	—	—	—	—	0	—	—	4%	—	1
n	8	30	56	7	30	131	6	39	25	24	94

Key: ARC=Atlatl Rock Cave; BMR=Boomerang Shelter; CCEA=Cowboy Cave, Early Archaic component; CCLA=Cowboy Cave, Late Archaic component; CCTA=Cowboy Cave Terminal Archaic component; DRS=Durango Rockshelters; OMCA=Old Man Cave, Early Archaic component; OMCB=Old Man Cave, Basketmaker II component; TFS=Three Fir Shelter.

[a]Durango Rockshelters data from Jones and Fonner (1954:Table 10).

Basketmaker II cordage, and the sum of all other twist sequences, which occur in amounts of less than 5 percent each, account for the remaining 7 percent of the Basketmaker II samples. The proportions of cordage twist structures evidence strong similarities among the Basketmaker II sites (χ^2=125.694, *p*= .000, *V*=.256). These data support the hypothesis that Basketmaker II peoples consistently chose the same raw materials and twisting methods for cordage production.

The pattern in re-plied Basketmaker II cordage demonstrates, albeit weakly, a Basketmaker II preference for 2(2z-S)Z, or Z re-plied, constructions. Although the small sample of re-plied cordage in this dataset does not warrant confidence in the proposed preference for Z re-plied constructions, other Basketmaker II cordage analysts have reported a similar pattern (Haas 2003:102, 2001:175; Kidder and Guernsey 1922:104; Lindsay et al. 1968:81; Peterson and McBrinn 2002; Schilz 1971:97). When only the final twist direction is considered for plied cordage and re-plied cordage, the average proportion of final Z twist to final S twist for each site is 85:15. Taken together, the preferences for 2s-Z and 2(2z-S)Z cordage demonstrates a preference for cordage with a final Z-twist.

TABLE 2. Cordage twist structures by site assemblage.

	Basketmaker II							Non-Basketmaker II				
	ARC	BMR	DRS[a]	OMCB	SDC[b]	TFS	n	OMCA	CCEA	CCLA	CCTA	n
2z-S	38%	3%	6%	14%	16%	13%	44	6%	51%	40%	63%	45
2s-Z	50%	80%	90%	57%	74%	87%	311	80%	41%	52%	38%	43
2(2z-S)Z	13%	—	2%	14%	7%	—	17	9%	5%	—	—	3
2(2s-Z)Z	—	—	1%	—	—	—	1	—	—	—	—	0
2(4z-S)Z	—	—	—	14%	—	—	1	6%	—	—	—	0
3B	—	—	—	—	—	—	0	—	3%	8%	—	3
3z-S	—	3%	—	—	—	—	1	—	—	—	—	0
3s-Z	—	3%	—	—	1%	—	2	—	—	—	—	0
3(2z-S)Z	—	3%	—	—	—	—	1	—	—	—	—	0
4s-Z	—	7%	—	—	2%	—	5	—	—	—	—	0
n	8	30	131	7	177	30	383	6	39	25	24	94
Final Z	63%	93%	95%	86%	84%	87%	338	83%	47%	57%	38%	45
Final S	38%	7%	5%	14%	16%	13%	45	17%	53%	43%	63%	46
n	8	30	131	7	177	30	383	6	38	23	24	91

Key: ARC=Atlatl Rock Cave; BMR=Boomerang Shelter; CCEA=Cowboy Cave, Early Archaic component; CCLA=Cowboy Cave, Late Archaic component; CCTA=Cowboy Cave Terminal Archaic component; DRS=Durango Rockshelters; OMCA=Old Man Cave, Early Archaic component; OMCB=Old Man Cave, Basketmaker II component; SDC=Sand Dune Cave; TFS=Three Fir Shelter.

[a] Durango Rockshelters data from Jones and Fonner (1954: Table 10) and Peterson and McBrinn (2002).

[b] Sand Dune Cave data from Lindsay et al. (1969:Table 14).

NON-BASKETMAKER II CORDAGE

Compared to the site assemblages of the Basketmaker II occupations, each of the non-Basketmaker II, or Archaic, assemblages evidence less design homogeneity. Although internally diverse, the early, late, and terminal Archaic occupations of Cowboy Cave (Jennings 1980; Schroedl and Coulam 1994) consist of similar proportions of cordage types. The early Archaic cordage samples from Old Man Cave appear to have a similarly diverse mix of cordage types, but the sample size is too small to warrant a confident statement of similarity or difference.

Ninety-four pieces of Archaic cordage were examined for material type (see Table 1). At 60 percent, bast fibers are the most abundant fiber type in the Archaic assemblages. Grass fibers account for 18 percent of the assemblages, and all other fiber types, which occur in proportions of less than 5 percent each, account for the remaining 22 percent. The Archaic cordage assemblages do not show strong differences in the proportions of materials (χ^2=54.576, p=.000, V=.440). Accordingly, it appears that there is no significant difference in the proportions of cordage-fiber materials in the non-Basketmaker II cordage assemblages.

As with the Basketmaker II samples, two-ply constructions dominate the Archaic assemblages. Forty-five percent of the 94 Archaic samples are 2z-S constructions. Forty-three percent are 2s-Z constructions, and the remaining 6 percent consist of re-plied and braided constructions. The Archaic cordage does not evidence a strong degree of difference in the proportions of twist sequences when all twist structures are considered (χ^2=20.249, p=.016, V=.268). Significantly, the material type appears to covary with the type of two-ply twist construction (χ^2=43.177, p=.000, V=.704). Of the 87 Archaic two-ply constructions, bast fibers account for 98 percent of the 2z-S constructions. 2s-Z cordage consists primarily of grass, bark, yucca, and animal fibers. The 2s-Z constructions generally appear to consist of relatively coarse materials and are thus combined under the term coarse-fiber cordage.

COMPARISON

The analysis of Basketmaker II and non-Basketmaker II assemblages suggests that the respective assemblages are internally consistent with respect to material choice and twist structure (Figure 5). 2s-Z yucca-fiber cordage dominates Basketmaker II assemblages, and 2z-S bast-fiber and 2s-Z coarse-fiber cordage dominates the Archaic assemblages. Because grass fibers—the fiber type that comprises most of the coarse-fiber cordage in the non-Basketmaker II assemblages—are not necessarily comparable to the stronger bast and yucca fiber cordage, cordage-type proportions should be limited to the latter two fiber types. Figure 6 shows that even after eliminating grass-fiber cordage, the samples are sufficient to reveal strong and significant differences in the proportions of Basketmaker II and non-Basketmaker II cordage populations.[5]

A BASKETMAKER II ENCULTURATION POOL

To this point, I have described some fundamental behaviors that produced cordage on the Colorado Plateau. Certain technical choices in material-selection and twisting behavior appear to offer equally viable alternatives for cordage production. Environmental constraints, technical constraints, cost considerations, or mechanical considerations alone cannot account for such technical choices. Instead, the artisan's learned production and/or cognitive behaviors weight technical choices in such material-selection and fiber-twisting activities. Because such mundane, low-visibility behaviors are generally transmitted at household- and band-level social interactions in nonindustrial societies, I expect spatial and

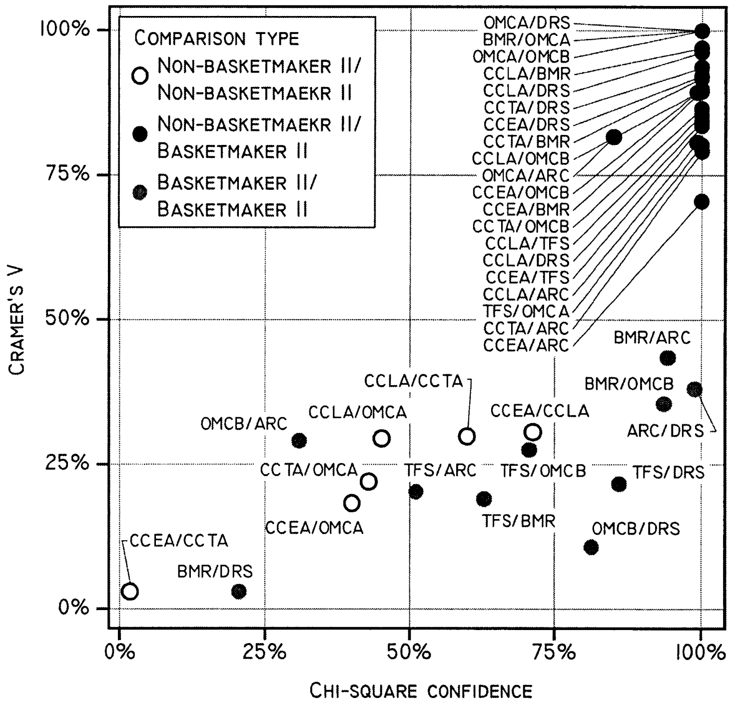

FIGURE 6. Intersite comparison of the proportions of cordage types. Each dot represents a comparison of the cordage-type proportions between two assemblages. Cordage types are based on a combination of material and twist structure and are limited to 2z-S or 2s-Z constructions and broadleaf yucca, narrowleaf yucca, or bast fibers. Comparison of Basketmaker II to non-Basketmaker II assemblages (solid black dots) evidences relatively strong and confident differences in the population proportions of cordage. (See Endnote 5 for additional statistical information, Figure 3 for key to site acronyms.)

quantitative variations in the archaeological occurrence of twist structures and certain materials to index the spatial and temporal extents of Basketmaker II enculturation pools.

The pattern of cordage design distributions presented in this analysis is robust. Clearly, 2s-Z yucca-fiber cordage dominates Basketmaker II cordage assemblages. Because the Basketmaker II assemblages evidence little apparent internal variation in material choice or twist structure, it seems that Basketmaker II peoples shared a common enculturative knowledge about which raw materials to collect and how to twist the fibers.

Moreover, the observed patterns in re-plied cordage indicate that learned behavior for cognizing the final-twist direction in cordage may also have influenced technical choices in Basketmaker II fiber-twisting activities. The preference for Z re-plied cordage (that is, cordage re-plied with a final Z twist) is significant in the context of an assemblage that primarily consists of 2s-Z cordage. The performance qualities of 2s-Z cordage weight the re-plying process in the S direction. One would expect Basketmaker II cordage manufacturers to produce re-plied cordage by simply plying two or more lengths of 2s-Z cordage in the S direction, thus resulting in S re-plied cordage. However, Basketmaker II peoples did not simply use readily available 2s-Z cordage to make re-plied cordage. Rather, Basketmaker II peoples first manufactured 2z-S cordage so that when re-plied, the final ply direction would be Z-wise. The result is that both plied and replied cordage in Basketmaker II assemblages consistently maintains a final ply direction of Z. Moreover, this preference for final-Z twist cordage appears to be consistent in Basketmaker II cordage assemblages from Durango to Kanab.

To be sure that the observed homogeneity in cordage structure is confined to Basketmaker II sites, I also considered temporally and spatially adjacent non-Basketmaker II cordage assemblages. The Archaic cordage assemblages from Old Man and Cowboy caves significantly differ from the Basketmaker II assemblages. 2z-S bast-fiber and 2s-Z coarse-fiber cordage dominates the Archaic assemblages.

The Basketmaker II assemblages also contrast with earlier and coeval Archaic assemblages from Bighorn Cave to the west and coeval assemblages from the Mogollon Highlands sites to the south. Hovazek and Geib (2002:119–121) report that juniper bark and 2z-S constructions dominate the cordage assemblages from Bighorn Cave. McBrinn (2002) reports that the cordage from the pre-ceramic levels of Tularosa and Bat caves exists in twist proportions of 60 to 40 percent for 2s-Z and 2z-S cordage, respectively (n=199). Accordingly, the non-Basketmaker II cordage data demonstrate that the internally homogeneous Basketmaker II assemblage is bounded in space and time. By extension, the Basketmaker II enculturation pool that produced the cordage appears to have been internally consistent and distinct from non-Basketmaker II enculturation pools.

DISCUSSION

The exceptional uniformity of Basketmaker II cordage design warrants explanation as to how such learned behaviors could diffuse so completely over an area of approximately 500,000 square kilometers and persist for approximately 1500 years. The pervasiveness of 2s-Z yucca fiber cordage in Basketmaker II sites accords with the widespread distribution of some Basketmaker II artifact traits but contrasts with apparent technical differences in other traits (Matson 1991, 1999; Morris and Burgh 1954; Webster and Hays Gilpin 1994). For example, in Basketmaker II sites throughout the Colorado Plateau, Webster and Hays Gilpin (1994:321) note similarities and differences in the Basketmaker II types of basketry and textiles. The authors conclude that "These overlapping spheres of technological and stylistic patterns suggest a population with diverse origins that is unified, or becoming unified, by a common ideology as well as a shared agricultural economy."

These cordage data corroborate the evidence for social unification. Given that other lines of evidence such as dentition and basketry technology evidence heterogeneity among Basketmaker II peoples (Matson 1991, 1999; Turner 1993; Webster and Hays-Gilpin 1994), the migration of people with a common origin does not appear to explain the pervasiveness of Basketmaker II cordage technology. Instead, I propose that intermarriage between adjacent bands best explains how cordage-manufacturing behaviors circulated throughout Basketmaker II society. In addition, a shared ideology about directionality may explain the extreme homogeneity of the Basketmaker II cordage assemblage.

The behavioral implications for cordage production deduced in this paper suggest that cordage-design attributes are unlikely to be transmitted through long range or short term person–person and person–artifact interactions. Instead, the transmission of cordage designs is more likely to occur in more intimate interactions such as those that occur within bands or households. Band-level social groups often interact across boundaries to mitigate inherent resource risks (Wobst 1974). One resource traded across social boundaries is mates (Weissner 1983). If mate-trading flows equally in all directions, knowledge of cordage production accompanies exogamous individuals, and that knowledge is transmitted to other members of a household or band, then intermarriage between bands could serve as a mechanism for diffusing a set of low-visibility, mundane behaviors through time and space.

Such a simplistic diffusion model alone cannot account for the extreme homogeneity of in Basketmaker II cordage assemblages, however. Why, for example, would one technical alternative diffuse more completely than another seemingly equally viable alternative? In fact, the low-visibility attributes of basketry technology evidence heterogeneity among some Basketmaker II sites (Webster and Hays-Gilpin 1994). A relational pattern in the cordage assemblages hints at a potential mechanism for the preferential diffusion of 2s-Z yucca-fiber cordage in Basketmaker II societies. In light of the 2s-Z-dominated assemblage, the dominance of Z re-plied cordage suggests that Basketmaker II peoples cognized the final ply direction in cordage. Twist constructions maintain poor absolute physical visibility, but high visibility in relatively intimate interactions. Given such contextual visibility, the final ply direction could have served a visual role in repetitive, short range, person–artifact interactions such as the binding of one's foot in a yucca-fiber sandal or the lashing of an infant to a cradle board. Ethnographic precedents suggest that an ideology about directionality may have been part of such interactions. Although it is not possible to know what ideology could have existed in the systemic context, ethnographic accounts demonstrate that other societies have imbued cordage-twisting activities and attributes with symbolic meaning related to directionality (Carr and Maslowski 1995:323; Minar 2000:98).

If symbolic meaning is ascribed to a particular technical choice in cordage manufacture, then that choice may become weighted during the knowledge-transmission process. Such preferential treatment of an activity choice would cause the set of activities to displace other technical alternatives that exist within an enculturation pool. The proposed knowledge-flow process is somewhat analogous to the concept of genetic dominance. For example, if an exogamous individual who maintains certain ideological concepts about twisting activities ("dominant" teacher) marries an individual with no ideologically-weighted preferences for cordage-production activities ("recessive" teacher), then I expect that students (offspring) will produce cordage in the manner of the ideologically-motivated teacher. The analogy of genetic dominance stops here, however, because the student in this scenario does not carry the "recessive" behaviors. Instead, the student is likely to maintain only the dominant behavior throughout his or her lifetime due to the perpetuation of the ideology and/or the automatization of motor skills (Minar 2000:97). The student is then inclined to pass on to others the dominant methods of cordage production.

Minar (2000:90) demonstrates how ideological phenomena might weight cordage twisting behavior. In an experiment designed to understand the factors that determine twist direction in cordage, Minar taught students how to *properly* twist cordage. The result is that all students ultimately produced cordage just as Minar taught them. In a cultural system where ideologies condition technical choices in cordage manufacture, the ideologically-weighted behaviors could be expected to diffuse relatively rapidly and over a large geographic extent within a marriage network. The diffusion would be particularly rapid and extensive in sparsely packed landscapes, such as that of the Basketmaker II peoples (Smiley 1997b).

SUMMARY

For at least 1500 years—beginning with the adoption of agriculture and ending with the transition to settled village life—Basketmaker II peoples subsisted in the unpredictable environment of the Colorado Plateau. Basketmaker II peoples appear to have diverse origins, and the inclusion of cultigens in Basketmaker II subsistence economies undoubtedly reduced mobility on the landscape. Despite such social fragmentation, Basketmaker II cordage design is surprisingly homogeneous and pervasive with respect to certain equifinal technical choices in raw-material selection and fiber-twisting behavior. The behavioral implications deduced in this paper and elsewhere (Carr and Maslowski 1995; Clark 2001; McBrinn 2002, 2005) suggest that cordage design is a function of enculturative training. It is unlikely that all Basketmaker II peoples would arrive at the same technical choices in such variables by chance alone. In fact, contemporaneous non-Basketmaker II peoples of the Southwest consistently made different technical choices in cordage manufacture. I infer that Basketmaker II peoples transmitted cordage-manufacturing behaviors through intermarriage between adjacent bands. I do not suggest that Basketmaker II bands consistently maintained amicable relationships with neighboring bands. Indeed, violence is well documented in the heart of Basketmaker II territory (Hurst and Turner 1993). Nor do I maintain that Basketmaker II peoples of geographic extremes maintained regular, direct interactions. Rather, these data suggest that Basketmaker II peoples participated in a clinal marriage network that was sufficiently articulated in time and space to allow for the diffusion of resources—as well as mundane knowledge of cordage production—throughout Basketmaker II society.

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NOTES

1. In modern fiber industries, yucca and agave fibers are termed hard fibers. In botanical terminology, hard fibers are referred to as vascular bundles. Vascular bundles are cemented together by lignin and consist of fibers, phloem, and xylem cells (Moore et al. 1995:287). The lignin in the vascular bundles of yuccas and agaves can be broken down chemically and/or mechanically to release the fibers. The resultant fiber mass is relatively soft compared to the stiff vascular bundles.
2. The Four Corners states of the U.S. Southwest contain 36 species of asclepias (U.S.D.A. 2005). Not all species of asclepias, however, contain bast fibers conducive to cordage manufacture. I have experimented with just a few species and found broadleaf milkweed *(A. latifolia [Torr] Raf.)* to have mechanical performance qualities comparable to apocynum fibers. Broadleaf milkweed occurs throughout the study region (U.S.D.A. 2005), but other equally viable milkweed species may also occur within the region. I make the assumption that the archaeological bast fibers observed in this study consist only of apocynum and the higher-quality milkweed species.
3. Samples rarely total 30 because (1) some assemblages contain fewer than 30

artifacts, (2) a sampling error on my part skewed the sample sizes at Cowboy Cave (Haas 2003:46), (3) some published data allow for larger sample sizes, and (4) some samples were removed post facto due to potential sampling bias (see footnote 4).

4. In my original analysis (Haas 2003), fur and feather cordage was included. Having since realized that such cordage potentially introduces sampling bias (see also footnote 3), I removed them from the present dataset. The culling process affected only the Atlatl Rock Cave and Old Man Cave assemblages. Two pieces from Atlatl Rock Cave (PNs 24.2.1 and 21.1) had fur wrappings, and much of the Old Man Cave assemblage was derived from just a few proveniences and had fur/feather wrappings. Although this culling process reduced the sample size, it appears to have had no significant effect on the results.
5. In Figure 6, the strength of the comparison is measured with Cramer's V index; comparisons that are as similar as possible have strength values of 100 percent and those that are as different as possible have values of 0 percent. The confidence of the sample is represented as a Chi-square confidence value; comparisons with the highest probability of sampling vagaries have confidence values of 0 percent and those with the least probability of sampling vagaries have values of 100 percent.

REFERENCES CITED

Adovasio, J. M., with R.L. Andrews

1986 Artifacts and Ethnicity: Basketry as an Indicator of Territoriality and Population Movement in the Prehistoric Great Basin. In *Anthropology of the Desert West, Essays in Honor of Jesse D. Jennings,* edited by Carol H. Condie and Don D. Fowler, pp. 43–88. Anthropological Papers 110. University of Utah, Salt Lake City.

Amsden, Charles

1930 What is Clockwise? *American Anthropologist* 32:579–580.

Bell, Willis H., and Carl J. King

1944 Methods for the Identification of Mescal *(Agave)*, Yucca *(Yucca)*, Bear-Grass *(Nolina)* and Sotol *(Dasylirion)*. *American Antiquity* 10:150–160.

Buchanan, Rita

1985 Using the Fibers of Native Plants. *Spin-Off.* December:29–34.

Campbell, Paul D.

1999 *Survival Skills of Native California.* Gibbs Smith Publisher, Salt Lake City.

Carr, Christopher

1995 A Unified Middle-Range Theory of Artifact Design. In *Style, Society, and Person: Archaeological and Ethnological Perspectives,* edited by C. Carr and J. E. Neitzel, pp.171–258. Plenum Press, New York.

Carr, Christopher, and Robert F. Maslowski

1995 Cordage and Fabrics: Relating Form, Technology and Social Processes. In *Style, Society, and Person: Archaeological and Ethnological Perspectives,* edited by C. Carr and J. E. Neitzel, pp. 297–340. Plenum Press, New York.

Clark, Jeffrey J.

2001 *Tracking Prehistoric Migrations: Pueblo Settlers among the Tonto Basin Hohokam.* The University of Arizona Press, Tucson.

Custer, Jay F.
2004 Cultural Context and Cordage Twist Direction. *North American Archaeologist* 25(2):139–152.

Emery, Irene
1966 *The Primary Structures of Fabrics: An Illustrated Classification.* The Textile Museum, Washington, D. C.
1952 Naming the Direction of the Twist in Yarn and Cordage. *El Palacio* 59: 251–262.

Geib, Phil R.
1996 *Glen Canyon Revisited.* University of Utah Press Anthropological Papers Number 119. University of Utah Press, Salt Lake City.

Geib, Phil R., Nancy J. Coulam, Victoria H. Clark, Kelley Ann Hays-Gilpin, and John D. Goodman II
1999 *Atlatl Rock Cave: Findings from the Investigation and Remediation of Looter Damage.* Navajo Nation Archaeology Department Report No. 93–121. Navajo Nation Archaeology Department, Window Rock, AZ.

Geib, Phil R., and Dale Davidson
1994 Anasazi Origins: A Perspective from Preliminary Work at Old Man Cave. *Kiva* 64(2):191–202.

Guernsey, Samuel J., and Alfred Vincent Kidder
1921 *Basket Maker Caves of Northeastern Arizona: Report on the Explorations, 1916–1917.* Papers of the Peabody Museum of American Archaeology and Ethnology Vol. 8, No. 2. Harvard University, Cambridge.

Haas, William Randall, Jr.
2001 The Basketmaker II Fiber Industry of Boomerang Shelter, Southeastern Utah: A Synthesis of Cordage Morphology Analysis and Experimentation. *Kiva* 67(2): 167–185.
2003 The Social Implications of Basketmaker II Cordage Style Distribution. Unpublished master's thesis, Department of Anthropology, Northern Arizona University, Flagstaff.

Hoover, Robert L.
1974 *Aboriginal Cordage in Western North America.* Occasional Paper No.1. I.V.C. Museum Society, El Centro, CA.

Hovezak, Mark, and Phil R. Geib
2002 Wood and Fiber Artifacts. In *Bighorn Cave: Test Excavations of a Stratified Dry Shelter, Mohave County, Arizona,* edited by P. R. Geib and D. R. Keller, pp. 108–133. Bilby Research Center Occassional Papers No. 1. Ralph M. Bilby Research Center, Northern Arizona University, Flagstaff.

Huckell, Bruce B.
1996 The Archaic Prehistory of the North American Southwest. *Journal of World Prehistory* 10(3):305–373.

Hurley, William M.
1979 *Prehistoric Cordage: Identification of Impressions on Pottery.* Aldine Manuals on Archeology 3. Taraxacum, Washington, D.C.

Hurst, Winston B., and Christy G. Turner II
1993 Rediscovering the "Great Discovery:" Wetherill's First Cave 7 and its Record of Basketmaker Violence. In *Anasazi Basketmaker: Papers from the 1990 Wetherill-Grand Gulch Symposium,* edited by Victoria Atkins, pp. 143–192. Cultural Resource Series No. 24. Bureau of Land Mangement, Salt Lake City.

Jakes, Kathryn A.
2000 Microanalytical Methods for Studying Prehistoric Textile Fibers. In *Beyond Cloth and Cordage,* edited by P. B. Drooker and L. D. Webster, pp. 51–68. University of Utah Press, Salt Lake City.

Jakes, Kathryn A., Hsiou-lien Chen, and Lucy R. Sibley
1993 Toward the Development of a Classification System for Plant Fibers. *Ars Textrina* 20:157–179.
Jennings, Jesse D.
1980 *Cowboy Cave.* University of Utah Anthropological Papers No. 104. University of Utah Press, Salt Lake City.
Jones, Volney H., and Robert L. Fonner
1954 Plant Materials from Sites in the Durango and La Plata Areas, Colorado. In *Basket Maker II Sites near Durango, Colorado,* by E. H. Morris and R.F. Burgh, pp. 93–122. Carnegie Institution of Washington Publication 604. Washington, D.C.
Kent, Kate Peck
1983 *Prehistoric Textiles of the Southwest.* University of New Mexico Press, Albuquerque.
Kidder, Alfred Vincent, and Samuel J. Guernsey
1922 Notes on the Artifacts and on Food. In *A Basket-Maker Cave in Kane County, Utah,* by Jesse L. Nusbaum, pp. 64–150. Indian Notes and Monographs, Miscellaneous Series No. 29. Museum of the American Indian, Heye Foundation, New York.
1919 *Archaeological Explorations in Northeastern Arizona.* Smithsonian Institution, Bureau of American Ethnology Bulletin No. 65. Government Printing Office, Washington, D.C.
Kluckhohn, Clyde, Willard Williams Hill, and Lucy Wales Kluckhohn
1971 *Navaho Material Culture.* The Belknap Press of Harvard University Press, Cambridge.
Leeds, John
1996 Making Cordage Fast. *Bulletin of Primitive Technology* 17:37–42.
Lindsay, Alexander, Jr., J. Richard Ambler, Mary Anne Stein, and Philip M. Hobler
1968 *Survey and Excavations North and East of Navajo Mountain, Utah, 1959–1962.* Glen Canyon Series No. 8. The Northern Arizona Society of Science and Art, Flagstaff.
Lockett, H. Claiborne, and Lyndon L. Hargrave
1953 *Woodchuck Cave: A Basketmaker II Site in Tsegi Canyon, Arizona.* Museum of Northern Arizona Bulletin 26. Northern Arizona Society of Science and Art, Flagstaff.
Maslowski, Robert F.
1996 Cordage Twist and Ethnicity. In *A Most Indispensable Art: Native Fiber Industries from Eastern North America,* edited by J. B. Petersen, pp. 88–99. The University of Tennessee Press, Knoxville.
Matson, R.G.
1991 *The Origins of Southwestern Agriculture.* University of Arizona Press, Tucson.
1999 The Spread of Maize to the Colorado Plateau. *Archaeology Southwest* 13:10–11.
Matson, R.G., and B. Chisholm
1991 Basketmaker II Subsistence: Carbon Isotopes and Other Dietary Indicators from Cedar Mesa, Utah. *American Antiquity* 56:444–459.
McBrinn, Maxine Elizabeth
2002 *Social Identity and Risk Sharing Among the Mobile Hunters and Gatherers of the Archaic Southwest.* Ph.D. dissertation, Department of Anthropology, University of Colorado, Boulder. Proquest, Ann Arbor.
2005 *Social Identities Among Archaic Mobile Hunters and Gatherers in the American Southwest.* Arizona State Museum Archaeological Series 197. The University of Arizona Press, Tucson.
Michelsen, Ralph C.
1974 Ethnographic Notes on Agave Fiber Cordage. *Pacific Coast Archaeological Society Quarterly* 10(1):39–48.
Minar, C. Jill
2000 Spinning and Plying: Anthropological Directions. In *Beyond Cloth and Cordage,* edited by P. B. Drooker and L. D. Webster, pp. 85–99. University of Utah Press, Salt Lake City.

Moore, Randy, W. Dennis Clark, Kingsley R. Stern, and Darrell Vodopich
1995 *Botany.* Wm. C. Brown Publishers, Dubuque.
Morris, Earl H., and Robert F. Burgh
1954 *Basket Maker II Sites near Durango, Colorado.* Carnegie Institution of Washington Publication 604. Washington, D.C.
Newton, Delores
1974 The Timbira Hammock as a Cultural Indicator of Social Boundaries. In *The Human Mirror: Material and Spatial Images of Man,* edited by M. Richardson, pp. 231–251. Louisiana State University Press, Baton Rouge.
Nusbaum, Jesse L.
1922 *A Basket-Maker Cave in Kane County, Utah.* Indian Notes and Monographs, Miscellaneous Series No. 29. Heye Foundation, New York.
Nyerges, Christopher
1996 The World is Tied Together with Fiber: The Value of Fiber in Primitive Cultures. *Bulletin of Primitive Technology* 17:12–14.
Osborne, Carolyn M.
1965 The Preparation of Yucca Fibers: An Experimental Study. In *Contributions of the Wetherill Mesa Archaeological Project,* compiled by Douglas Osborne, pp. 45–50. Memoirs of the Society for American Archaeology No. 19. University of Utah Printing Service, Salt Lake City.
Osborne, Douglas, and Carolyn M. Osborne
1954 Twines and Terminologies. *American Anthropologist* 56:1093–1101.
Peterson, Cristina, and Maxine McBrinn
2002 *A New Spin on Cordage: The Effects of Material and Culture.* Poster Presented at the 67th Annual Meeting of the Society for American Archaeology, Denver.
Rathje, William L., and Michael Brian Schiffer
1982 *Archaeology.* Harcourt Brace Jovanovich, New York.
Robbins, Wilfred William, John Peabody Harrington, and Barbara Friere-Marreco
1916 *Ethnobotany of the Tewa Indians.* Smithsonian Institution Bureau of American Ethnology Bulletin No. 55. Government Printing Office, Washington, D.C.
Robins, Michael R.
1997 Modeling the San Juan Basketmaker Socio-Economic Organization: A Preliminary Study in Rock Art and Social Dynamics. In *Early Farmers in the Northern Southwest: Papers on Chronometry, Social Dynamics, and Ecology,* edited by F. E. Smiley and M. R. Robins, pp. 73–120. Animas-La Plata Archaeological Project Research Paper No. 7. Northern Arizona University, Flagstaff.
Schiffer, Michael Brian
1996 *Behavioral Archaeology: First Principles.* University of Utah Press, Salt Lake City.
Schiffer, Michael Brian, and James M. Skibo
1997 The Explanation of Artifact Variability. *American Antiquity* 62(1):27–50.
Schilz, Allan John
1979 The Desha Caves: Two Basketmaker Sites in Southeast Utah. Unpublished master's thesis, Department of Anthropology, California State University, Los Angeles.
Shroedl, Alan R., and Nancy J. Coulam
1994 Cowboy Cave Revisited. *Utah Archaeology* 7(1):1–34.
Smiley, Francis E.
1997a Toward Chronometric Resolution for Early Agriculture in the Northern Southwest. In *Early Farmers in the Northern Southwest: Papers on Chronometry, Social Dynamics, and Ecology,* edited by F. E. Smiley and M. R. Robins, pp. 13–42. Animas-La Plata Archaeological Project Research Paper No. 7. Northern Arizona University, Flagstaff.
1997b Regional Packing, Group Dynamics, and the Diffusion of Innovation. In *Early Farmers in the Northern Southwest: Papers on Chronometry, Social Dynamics, and Ecology,* edited

by F. E. Smiley and M. R. Robins, pp. 59–72. Animas-La Plata Archaeological Project Research Paper No. 7. Northern Arizona University, Flagstaff.

Smiley, Francis E., and Michael R. Robins (editors)
1997 *Early Farmers in the Northern Southwest: Papers on Chronometry, Social Dynamics, and Ecology.* Animas-La Plata Archaeological Project Research Paper No. 7. Northern Arizona University, Flagstaff.

Smiley, Francis E., and William J. Parry
2001 Rethinking the Agricultural Transition in the Northern Southwest: Evidence from Three Fir Shelter. Manuscript on file, Northern Arizona University, Flagstaff.

Smith, Bruce D.
2001 Low Level Food Production. *Journal of Archaeological Research* 9:1–43.

Turner, Christy G.
1993 Southwest Indians: Prehistory through Dentition. *National Geographic Research and Exploration* 9(1):32–53.

United States Department of Agriculture (U.S.D.A.)
2005 The PLANTS Database, version 3.5 (http://plants.usda.gov). Data compiled from various sources by Mark W. Skinner. National Plant Data Center, Baton Rouge, LA.

Webster, Laurie D., and Kelley Hays-Gilpin
1994 New Trails for Old Shoes: Sandals, Textiles, and Baskets in Basketmaker II Culture. *Kiva* 64(2):313–327.

Wendrich, Willemina
1991 *Who is Afraid of Basketry: A Guide to Recording Basketry and Cordage for Archaeologists and Ethnographers.* CNWS Publications No. 6. Leiden University Centre for Non-Western Studies, Leiden, The Netherlands.

Wheat, Margaret
1967 *Survival Arts of the Primitive Paiutes.* University of Nevada Press, Reno.

Wiessner, Polly
1983 Style and Social Information in Kalahari San Projectile Points. *American Antiquity* 48:253–274.

Wills, Wirt H.
1995 Archaic Foraging and the Beginning of Food Production in the American Southwest. In *Last Hunter, First Farmers: New Perspectives on the Prehistoric Transition to Agriculture,* edited by T. Douglas Price and Anne Birgitte Gebauer, pp. 215–242. School of American Research Press, Santa Fe.

Wobst, H. Martin
1974 Boundary Conditions for Paleolithic Social Systems: A Simulation Approach. *American Antiquity* 39:147–178.

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