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LATE HOLOCENE CLIMATE CHANGE AND THE ORIGIN OF THE ''FIGURINE COMPLEX'' IN GRAND CANYON, ARIZONA

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Hundreds of split-twig figurines have been recovered from caves in Grand Canyon and are associated with a hunting ritual that dates from 4200–3100 ^{14}C yrs before present (BP). The caves chosen for this ritual all have Pleistocene remains of big game animals visible in packrat middens or surface deposits at the entrances. Presumably, Archaic hunter-gatherers identified these sites as entrances to the Underworld where the fossil remains represented ancestral animals. We examine the known chronology for these sites in Grand Canyon and postulate that the origin of this ritual is correlated with a period of rapid climate change that occurred on both global and regional scales beginning at ~4000 BP. Increasingly variable conditions and the onset of modern El Niño Southern Oscillation (ENSO) patterns in the eastern Pacific at that time probably negatively affected productivity of big game species in years with decreased winter precipitation. Thus, the caves became foci for a hunting ritual with figurines serving as a kind of offering. Most dates on the figurines or associated artifacts occur between 4100–3530 BP and many cluster to specific periods that suggest this ritual was not continuous, but may correspond with episodic droughts. Additional radiocarbon dates on figurines can test this hypothesis.

Key words: *split-twig figurines, Grand Canyon, climate change, hunting ritual*

Cientos de estatuillas de split-rama se han recuperado de cuevas en el gran cañón y se asocian a un ritual de caza que se remonta a 4200-3100 14 años C antes de presenta (BP). Las cuevas para este ritual todos tienen Pleistocenos restos de animales de caza mayor en packrat middens y depósitos superficiales en las entradas. Presumiblemente, cazadores-recolectores arcaicos identifican estos sitios como entradas al inframundo donde los restos fósiles animales ancestrales representados. Examinamos la cronología conocida por estos lugares en el gran cañón y postulan que el origen de este ritual se relaciona con un período de cambio climático rápido que ocurrió en escalas globales y regionales, empezando en ~ 4000 BP. Aumento de condiciones variables y la aparición de patrones del Niño Oscilación Sur (ENOS) modernos en el Pacífico oriental en aquel momento probablemente negativamente afectados productividad de especies de caza mayor en años con precipitaciones invernales disminuida. Así, las cuevas se convirtieron en focos para un ritual de caza con figuras que sirve como una especie de ofrenda. Más fechas en la figuras o artefactos asociados se producen entre 4100–3530 BP y muchos racimo a períodos específicos que sugieren que este ritual no era continua, pero puede corresponder con las sequías episódicas. Fechas de radiocarbono adicional en figurillas pueden probar esta hipótesis.

Introduction

Since the first split-twig figurine was discovered in Utah in 1930 and Grand Canyon in 1933 (Wheeler 1939; Coulam and Schroedl 2004), these artifacts continue to fascinate and intrigue archaeologists (Figure 1). Most of these artifacts have been recovered from Grand Canyon and there is little doubt that the center of the 'figurine complex' is in this region. All these artifacts date between 4400–3100 ^{14}C yrs before present (BP), with most falling into a narrower

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Figure 1. A typical split-twig figurine as found *in situ* at Shrine Cave, Grand Canyon.

time period between 4100–3500 BP. The exact role of these objects in Archaic culture will never be known, but the most logical explanation is that they were used in a hunting ritual as a form of offering to enhance the hunter's success. This interpretation is based on the discovery of at least six figurines with a small spear in their sides, and six others with an artiodactyl's dung pellet purposely placed inside. Furthermore, all figurine sites in Grand Canyon were only used for this ritual by the Archaic hunters; no evidence for habitation has been found at any of these sites. Figurines that have been found at sites outside Grand Canyon are often constructed differently from the Grand Canyon artifacts, do not date to the same period and are usually much younger in age, and likely did not have a similar function (Coulam and Schroedl 2004).

A possible reason for why figurines are found primarily in Grand Canyon caves may relate to the depth and association of fossil remains at the entrances to these sites. Hundreds of caves exist in the canyon and an analysis by Emslie et al. (1987, 1995) indicated that all figurine sites are in caves that are both deep enough to have a dark zone where light no longer penetrates, and where bones, teeth, and/or dung of extinct and extant big game animals are preserved and visible on the surface. Thus, if Archaic hunters had an origin myth from the Underworld, similar to many southwestern Native American groups today, these caves may have represented entrances to that Underworld. Such a belief also would have

been reinforced by the discovery of big game remains at the cave entrances, including those of 'ancestral' animals no longer present today such as the extinct Harrington's mountain goat (*Oreamnos harringtoni* Stock). No mountain goat species survived the late-Pleistocene extinctions near Grand Canyon, and sub-fossil remains and dung of these animals would have been readily recognized as very different from modern taxa such as bighorn sheep (*Ovis canadensis* Shaw). Well-preserved fossils and dung of mountain goat are frequently found on the surface of caves in Grand Canyon where the dry, arid environment is conducive for long-term preservation (Mead et al. 1986).

Although much has been written on the probable function of split-twig figurines in Archaic culture, especially as part of a hunting ritual, the reason for their sudden appearance and disappearance in caves in Grand Canyon between 4400 to 3100 BP has not been addressed. Here, we discuss the possible role of climate as a driving force in establishing the apparent ritual use of caves in Grand Canyon. We refer to all dates in ^{14}C yrs before present (BP) as most paleoclimatic data are reported in this manner and allow easier comparison to figurine dates. We hypothesize that a more variable climate and the onset of modern El Niño Southern Oscillation (ENSO) patterns in the Southwest beginning at about ~4000 BP (Barron and Anderson 2011) caused periodic droughts and a subsequent decline in big game species that impacted hunter-gatherer subsistence in this region. Loss of primary food resources may have stimulated hunting rituals at the openings of dark caves, where fossil remains also were found. Thus, figurines became a form of prayer or offering to ancestors at presumed entrances to the Underworld.

Background Information

A complete review of the literature on split-twig figurines is not provided here. Previous reviews have thoroughly discussed all relevant papers related to these artifacts, including methods of construction and presumed function (e.g., Schroedl 1977; Emslie et al. 1995; Coulam and Schroedl 2004). Coulam and Schroedl (2004) found two distinct styles of manufacture for these artifacts (Green River and Grand Canyon styles) as well as two types of sites where they are found, domestic and ritual. Domestic sites, such as the Newberry and Cowboy caves, were occupation sites while ritual sites were never used for anything except placement of figurines. Only the latter type of site occurs in Grand Canyon and we concentrate our discussion on these, where the center of the 'figurine complex' appears to have been focused.

Coulam and Schroedl (2004) also described all Grand Canyon sites as 'increase centers' where figurines represented totem animals placed in caves by members of an Archaic bighorn sheep clan. Similar to Emslie et al. (1987, 1995), Coulam and Schroedl (2004) also postulated that this hunting ritual developed in Grand Canyon at the openings of deep caves that may have represented entrances to the Underworld, but did not credit these earlier papers where this hypothesis was first proposed.

Coulam and Schroedl (2004) further hypothesized that split-twig figurines originated through a hunting ritual by a bighorn sheep clan in Grand Canyon

beginning about 2900 B.C., but offer no substantive evidence for this claim. Indeed, of the over 400 figurines that have been reported and described in the literature, only a handful actually have antler or horn-like appendages included in their construction (see Schwartz et al. 1958). A few others have a dung pellet of an unidentified artiodactyl purposely placed inside. If the figurines, especially those in Grand Canyon, were meant to represent primarily bighorn sheep, one would expect more of these artifacts to be constructed with horns, especially curled horns to clearly represent this animal. In addition, one would also expect the postulated bighorn sheep clan to leave skulls, horns, or other parts of this species in direct association with the figurines.

For these reasons, we do not believe the figurine complex originated with a bighorn sheep clan that ''adopted this symbol to identify its members in opposition to members of other clans'' (Coulam and Schroedl 2004:43). Instead, we present here evidence that links the origination of the figurine complex with loss of big game species from climate change and periodic droughts in western North America beginning at about 4200 BP.

Mid to Late Holocene Climate Change

There is considerable evidence for a mid- to late-Holocene climate disruption that occurred on a global, as well as regional, scale. The idea of an extended mid-Holocene warm/dry period beginning 7500 years ago and ending 4000 years ago has been proposed since the 1930s, perhaps best described by Antevs (1955) as the Altithermal Long Drought. However, recent work with more robust chronologies and much higher spatial resolution has demonstrated that the concept of a uniform, global climate pattern for the middle Holocene is erroneous. The Sahara Desert in Africa, for example, was significantly wetter than present during a ''greening'' episode throughout most of the Altithermal, and only began to dry out after 4200 yrs BP (Kröpelin et al. 2008; Giraudi et al. 2013).

Instead of conceptualizing a mid-Holocene drought that is the equivalent of glaciations in their global extent, a more regional examination of climate conditions is warranted. First, ice-core records from Greenland indicate a period of rapid warming and drier conditions that began at about 4200 ^{14}C yrs BP in the Arctic (Mayewski and White 2002). Further, these authors found that a sharp decrease in chloride in the ice-core record at this time suggests that less sea ice was present and that warmer and drier climates prevailed in the North Atlantic as a result. These changes in turn are correlated with the collapse of the Mesopotamian and Akkadian Empires at 4200 BP (Mayewski and White 2002). An et al. (2005) similarly found evidence for rapid climate change at 4000 BP in the North Atlantic, Africa, and Near East. All these areas had concomitant impacts on cultures. For example, at least six Neolithic cultures collapsed abruptly at ~4000 cal yrs BP in China and other regions of Asia as a result of severe drought (Liu and Feng 2012).

In North America, Booth et al. (2005) found widespread evidence for abrupt severe drought in mid-continental U.S. at 4200 BP. This drought caused an increase in forest fires as evinced by abundant charcoal in sediments in Michigan. Furthermore, this drought may have lasted decades to centuries, with continued

increases in forest fires and persistence of La Niña-like conditions. Toomey et al. (1993) used fossil data on vertebrates, pollen, and plant macrofossils from the Edwards Plateau, Texas, to show that a drier than modern period occurred there from 5000 to 2500 BP. Moreover, the diatom record from lakes in the northern Rocky Mountains shows cyclic droughts beginning at 4500 BP (Stone and Fritz 2006). A period of severe drought lasted from 4500 to 3500 BP, with warmer temperatures in the northern Rockies compared to today.

In the eastern Pacific, modern-like ENSO patterns began to predominate at ~4000 BP leading to more variable climate than during the preceding early to middle Holocene (Barron and Anderson 2011). This variability resulted in some areas becoming more mesic with increased winter moisture, while other areas were drier and experienced periods of prolonged droughts. For example, wetter conditions are implied from cave speleothems in New Mexico and Idaho (Polyak and Asmerom 2001; Lundeen et al. 2013) as well as charcoal deposits in alluvial fans in New Mexico (Frechette and Meyer 2009). However, lake and other sediment records in Arizona and Nebraska indicate the opposite with drier conditions present by 4000 BP (Waters and Haynes 2001; Miao et al. 2007; Schmieder et al. 2012). It is likely then, that the increased variability in ENSO events and climatic patterns caused alternating wet and dry conditions to occur more frequently. Dry winters and droughts in spring/summer would in turn cause increased forest fires as has been documented in Arizona and New Mexico with tree ring and historic records over the past 300 years (Swetnam and Betancourt 1990).

Closer to Grand Canyon, Weng and Jackson (1999) examined sediment cores from Fracas and Bear Lake on the Kaibab Plateau north of Grand Canyon. The Bear Lake core showed slight increases in charcoal fragments at ~4700 cal yr BP (=~4495 BP), implying an increase in forest fires due to drier conditions at that time. They also found evidence for a severe drop in lake levels in the mid-Holocene indicating a very dry period in the region from ~6800–2700 BP. Pollen analysis from packrat middens in Chaco Canyon, New Mexico, also revealed evidence for aridization at 5100 BP (Drake et al. 2012).

Climate and Big Game Species

Archaeological evidence from numerous Archaic occupation sites indicate that large mammals formed an important part of their subsistence, especially deer and pronghorn (Fowler and Madsen 1986). Given that the climate was becoming more variable in the Southwest at about 4000 BP, how did these changes affect the wildlife, especially the big game animals on which hunter-gatherers were dependent? Several studies on bighorn sheep productivity indicate the impact that even minor periods of drought can have on these species. For example, Portier et al. (1998) completed a study of bighorn sheep in the Canadian Rockies from 1975–1996. They showed that winter survival of lambs is positively correlated with weather and precipitation during the previous spring. In addition, Bender and Weisenberger (2005) also found that the amount of precipitation was correlated to survival of desert bighorn sheep lambs in New Mexico. Specifically, the amount of precipitation likely affects forage quality and quantity, thereby impacting the sheep's habitat.

For pronghorn (*Antilocapra americana* Ord), Bright and Hervert (2005) found that drought conditions in the Sonoran region to be an important factor in adult and

Figure 2. One of eleven cairns found in Crescendo Cave, Grand Canyon, with several long, unmodified and split sticks in association. This cairn is Cairn 5 as described by Emslie et al. (1995).

fawn survival. The higher mortality was caused by a combination of lack of water and absence of nutritious forage. Desert mule deer (*Odocoileus hemionus* Rafinesque) are similarly affected. Smith and LeCount (1979) completed a nine-year study of this species in Arizona and found a strong correlation between winter precipitation, forb and small shrub productivity, and fawn survival. Lawrence et al. (2004) studied deer survival for nearly three years in southwest Texas. They also found a direct correlation between periods of drought with adult female and fawn survival.

These studies indicate that warmer and drier conditions in the Greater Southwest during the mid- to late-Holocene would negatively impact populations of big game species that Archaic hunter-gatherers exploited (see also review by Byers and Smith 2007). Thus, it is likely that climate change at this time forced changes in Archaic culture and the development of a hunting ritual at caves in Grand Canyon.

Temporal Range of Grand Canyon Figurines

To further support our contention that the origin of the figurine complex in Grand Canyon was related to climate change, we compiled all known radiocarbon dates associated with this complex. These 15 dates include those taken directly from figurines (eight) as well as dates on associated artifacts from figurine sites (seven). These other artifacts include unmodified or split sticks found with figurines or under cairns in sites where figurines also were found. Only one site, Crescendo Cave, did not produce any figurines with the numerous rock cairns, unmodified sticks and stick artifacts found in the cave (Figure 2; Emslie et al. 1995). Although the date from one stick associated with a cairn in

Table 1. Radiocarbon dates taken directly on split-twig figurines, or indirectly from associated artifacts, from sites in Grand Canyon, Arizona. Dates are reported as ^{14}C years before present with standard deviation.

Site	Lab no.	Date	S. D.*	Reference
Direct Dates				
Tse-An-Kaetan	AA-47	3100	110	Schwartz et al. 1958
Tse-An-Kaetan	M-563	3530	300	Schwartz et al. 1958
Rebound Cave	NZA 10572	3590	60	Coulam and Schroedl 2004
Rebound Cave	NZA 10575	3709	60	Coulam and Schroedl 2004
Rebound Cave	NZA 10574	3727	70	Coulam and Schroedl 2004
Rebound Cave	NZA 10577	3793	70	Coulam and Schroedl 2004
Rebound Cave	NZA 10576	3852	60	Coulam and Schroedl 2004
Stantons Cave	UCLA-741	4095	100	Euler and Olson 1965
Indirect Dates				
Left Eye Cave	Beta-63377	3700	60	Emslie et al. 1995
Shrine Cave	AA 1500	3750	140	Emslie et al. 1987
Five Windows Cave 3	Beta-63376	3850	60	Emslie et al. 1995
Horn Creek Cave	GX-5008	3940	160	Emslie et al. 1987
Right Eye Cave	Beta-63379	4030	100	Emslie et al. 1995
Rebound Cave	Beta-63378	4050	100	Emslie et al. 1995
Crescendo Cave	Beta-63375	4390	130	Emslie et al. 1995

Note: *Standard Deviation

Crescendo Cave is older than any previously recorded dates on this complex in Grand Canyon, we believe it should be included here (contrary to Coulam and Schroedl [2004] in their review of this complex) as this site is similar to all other figurine sites in the construction of cairns and placement of sticks and other artifacts in association. Moreover, it is possible that figurines do occur under some of these cairns in Crescendo Cave, but they have not been excavated.

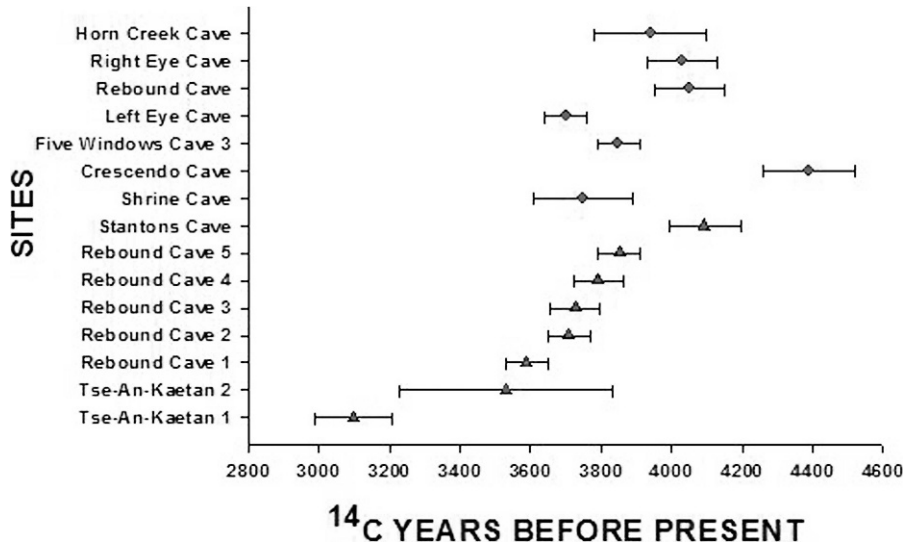

Figure 3. Radiocarbon dates on split-twig figurines (direct dates, triangles) or on unmodified sticks in association with cairns (indirect dates, circles) from caves in Grand Canyon, Arizona.

Figure 4. A cache of three split-twig figurines placed in a circular pattern as found under a cairn at Rebound Cave, Grand Canyon. This cairn is Cairn 9 as described by Emslie et al. (1995).

All 15 dates from Grand Canyon indicate a narrow temporal range of 4390–3100 BP for this complex (Table 1 and Fig. 3). Although this range extends over 1000 years, if the oldest and youngest dates are removed from consideration, the remaining dates form a tighter cluster ranging from 4095–3530 BP, or a period of only about 500 years. These remaining dates also form several distinct clusters in age. For example, the older dates from Stantons, Rebound, and Right Eye caves are essentially contemporaneous in the 4000s BP, with that from Horn Creek nearly so. The date from Five Windows Cave 3 is identical to one other date from Rebound Cave at 3850 BP. In addition, other dates from Rebound Cave in the 3700s BP, with

those from Left Eye and Shrine Cave are essentially contemporaneous, as are the younger dates in the 3500s from Tse-an-Kaetan and Rebound caves.

These clusters of figurine dates suggest that the ritual being performed in the caves was episodic, and not continuous through time as one might expect with clan operations. These data are also in accordance with a climate model for explaining the episodic, ritualistic use of the caves in periods of drought, and subsequent impacts on wildlife would be cyclic. This cyclicity could be explained in part by periodic ENSO events. It is of interest to note that more direct dates on figurines have been reported from Rebound Cave than from any other site, and that these dates show the greatest range in variation. This range, plus the specific clusters, suggests that Rebound Cave was visited at least three, and perhaps as many as five times between 4050 and 3700 BP. It is notable that Rebound Cave also had one cluster of three figurines cached under at least one of the cairns (Figure 4; Emslie et al. 1995). It is likely that additional dates on other sites would reveal similar variation in age for these artifacts and perhaps additional clusters of the dates that might represent periodic, rather than continuous visits to these caves. Future research should be directed at completing multiple radiocarbon dates on figurines or related artifacts at more sites. If multiple figurine dates from each site produced clusters that overlap in age with other sites, it would support our hypothesis that these caves were visited only occasionally, as predicted by our climate hypothesis.

Split-twig figurines appear to have had a unique function in Grand Canyon, compared to those found in different contexts in other regions of the Southwest (Coulam and Schroedl 2004), and nowhere else have they been placed in association with fossil packrat middens and Pleistocene fossils. Current evidence supports Grand Canyon as the center of origin for this artifact and associated hunting ritual that we believe manifested during periods of climatic stress.

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