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Lennon N. Bates
Department of Chemistry, University of Central Arkansas

Amanda M. Castañeda
Ancient Southwest Texas Project, Texas State University

Carolyn E. Boyd
Department of Anthropology, Texas State University

Karen L. Steelman
Department of Chemistry, University of Central Arkansas

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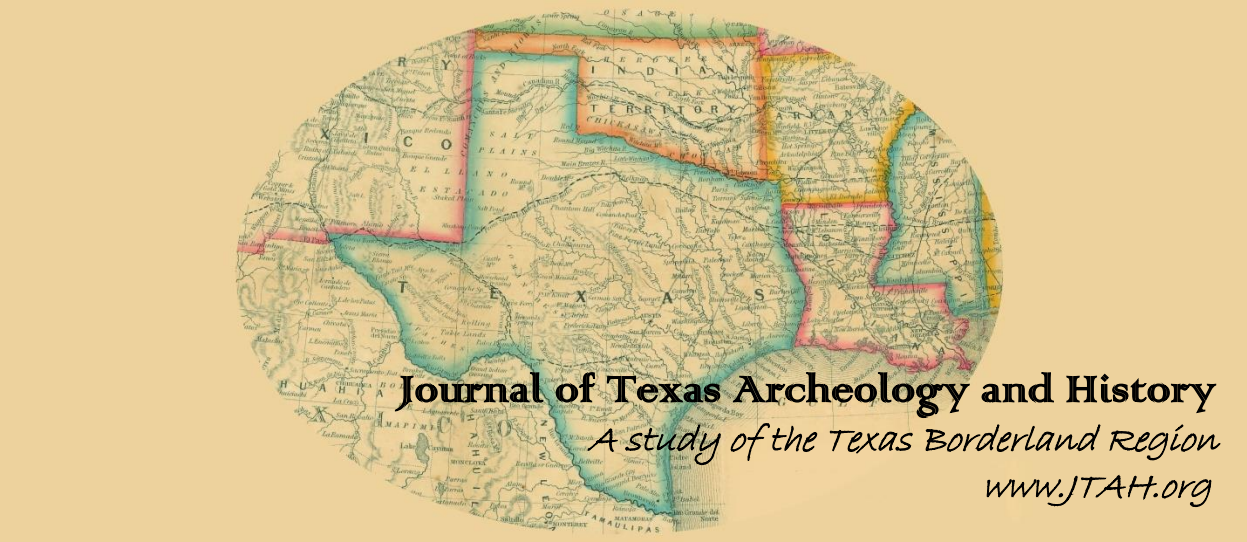

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Author(s): *Lennon N. Bates, Amanda M. Castañeda, Carolyn E. Boyd, and Karen L. Steelman*

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A BLACK DEER AT BLACK CAVE: NEW PICTOGRAPH RADIOCARBON DATE FOR THE LOWER PECOS, TEXAS

Lennon N. Bates, Amanda M. Castañeda, Carolyn E. Boyd, and Karen L. Steelman

ABSTRACT

A Pecos River style painting of a black deer from Black Cave Annex (41VV76a) in southwest Texas was radiocarbon dated. Using plasma oxidation and accelerator mass spectrometry, we obtained an age of 1465 ± 40 RCYBP (2 sigma calibrated age range of A.D. 470-660). This age is younger than the accepted age range for Pecos River style paintings, which is approximately 4000-3000 years B.P. This new measurement in association with other younger dates prompts us to question whether the Pecos River style endured for a longer time period than previously thought. More radiocarbon research is needed in order to understand how this anomalous result might fit within the Lower Pecos Canyonlands rock art chronology.

Keywords: Pecos River Style, rock art, pictographs, plasma oxidation, radiocarbon dating

INTRODUCTION

In the 1990s, archeologists and chemists began to collect paint samples in the Lower Pecos River region of Texas in order to radiocarbon date the different pictographic styles. This region was the original study area for Dr. Marvin Rowe and his laboratory at Texas A&M University, when developing the plasma chemical-extraction technique to date pictographs (Russ et al. 1990). The chronology for the Lower Pecos rock art (Figure 1) is based on 29 Pecos River Style dates (Table 1); one date for a Red Monochrome image at 41VV233 (CAMS-11891: 1125 ± 85 RCYBP, hereafter, years B.P); one date for a Red Linear image at 41VV162a (AA-10549: 1280 ± 150 years B.P.); and one for a stylistically unclassified charcoal deer at 41VV75 (CAMS-29315: 1280 ± 80 years B.P.) (Hyman and Rowe 1997; Rowe 2004, 2005; Boyd et al. 2014; Steelman et al. in prep.). These dates are associated with 15 images from 10 sites. All were determined using plasma oxidation and AMS radiocarbon dating.

For the Pecos River Style, there are 20 accepted radiocarbon dates, ranging from 4200 to 2750 years B.P. (Hyman and Rowe 1997; Rowe 2004, 2005; Steelman et al. in prep.). An additional three results were rejected due to high levels of background contamination in the unpainted rock or laboratory error associated with replicate measurements (see Chaffee et al. 1993; Pace et al. 2000; Rowe 2004 for a detailed explanation regarding these results). Six other dates at San Vicente in

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Mexico and the White Shaman site in Texas were also considered unreliable due to younger results outside the expected age range for the style, even though there was no laboratory reason to do so (Rowe 2004, 2005; Steelman et al. in prep.). In this study, we report a new radiocarbon result for a black manganese-pigmented deer at Black Cave Annex (41VV76a), the first Pecos River style deer to be dated. We obtained a radiocarbon age of 1465 ± 40 years B.P., calibrated at 2 sigma to A.D. 470-660, which is also younger than the currently accepted range for the style (Figure 1 and Table 1). This new result, as well as previously obtained younger dates, have prompted us to investigate the temporal span of Pecos River style pictographs. The purpose of this article is not to complete a comprehensive, comparative review of all Pecos River style radiocarbon dates, as this requires the full attention of a separate manuscript (Steelman et al. in prep.). Instead, we intend to describe the procedure and context of the newly acquired radiocarbon date so it can be positively identified as Pecos River style, shown to have been obtained using proper laboratory methods, and provide an incentive for reconsidering what we thought we knew about the age of Pecos River style pictographs.

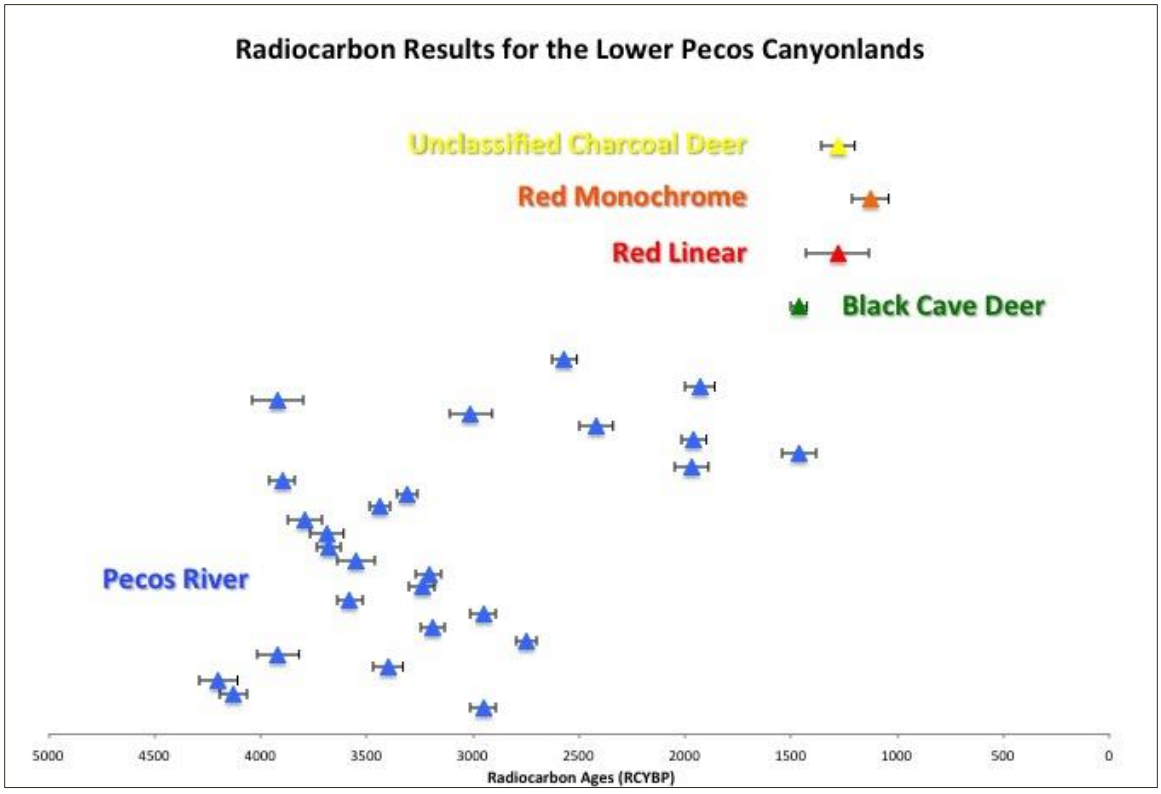

Figure 1. Age results for Pecos River style, Red Linear style, Red Monochrome style, and an unclassified charcoal deer. The green triangle represents the new result obtained in this study. Error bars represent the 1 sigma counting error of the AMS measurement.

Table 1. Radiocarbon results for the Pecos River Style (Hyman and Rowe 1997; Rowe 2004, 2005; Steelman et al. in prep.).

Site and Sample No.	AMS ID	Radiocarbon Age (years BP)	Corrected Age (years BP)
41VV75			
1	ETH-5909	3865 ± 100	3920 ± 100
29A	CAMS-17316	2750 ± 50	
29B	CAMS-17897	3190 ± 60	
37A	CAMS-14087	2950 ± 60	
37B	CAMS-14088	3580 ± 60	
37C	CAMS-14089	3240 ± 60	
37D	CAMS-14090	3210 ± 60	
37E	CAMS-17990	3550 ± 90	
37F	CAMS-18206	3680 ± 60	
47A	CAMS-23927	3690 ± 80	
47B	CAMS-25384	3790 ± 80	
47C	CAMS-26762	3440 ± 50	
47D	CAMS-25368	2340 ± 80	rejected
47E	CAMS-25885	3310 ± 50	
47F	CAMS-25884	3900 ± 60	
Jackrabbit Shelter 41VV576			
1a	ETH-6962	3355 ± 65	4130 ± 65
1b	AA-7063	4200 ± 90	
3A	ETH-7047	3000 ± 70	3400 ± 70
3B	AA-8426	1450 ± 75	rejected
Crab Shelter 41VV50			
3A	AA-8699	2950 ± 60	
White Shaman 41VV124			
1	CAMS-34204	1970 ± 80	
2	CAMS-48212	1460 ± 80	
3A	CAMS-60896	1960 ± 60	
4	CAMS-60935	2420 ± 80	
Cedar Springs 41VV696	CAMS-62184	3010 ± 100	
Mystic Shelter 41VV612	CAMS-25882	3920 ± 120	
San Vicente			
2	CAMS-43673	1930 ± 70	
3	CAMS-45378	2570 ± 60	
Abrigo Diego			
2a	CAMS-45379	2500 ± 60	rejected
Black Cave Annex			
41VV76a	CAMS-152885	1465 ± 40	

LOWER PECOS CANYONLANDS

The Lower Pecos River region is a rocky, semi-arid canyonland located in southwestern Texas and northern Mexico (Turpin 1995, 2004). The area is centered on the confluence of the Pecos River and the Rio Grande, extending approximately 160 kilometers in each direction (Turpin 1995). The region is situated at the boundary of three major vegetation zones in North America: the Tamaulipan Thorn Shrub of northeastern Mexico and southern Texas; the Edwards Plateau Oak–Juniper; and the Sotol–Lechuguilla Chihuahuan Desert Shrub of Trans–Pecos Texas and north central Mexico (Dering 1999; Turpin 2004). This landscape is capped by a thick layer of Cretaceous limestone, and incised by deep, narrow canyons. Wind, water, and chemical weathering have created thousands of rock shelters in the canyon walls.

Over the last 13,000 years, the rock shelters have provided refuge for the prehistoric inhabitants of the region (Shafer 1986; Turpin 2004). Due to the dry conditions, the Lower Pecos contains one of the oldest and best-preserved records of hunter-gatherer lifeways in North America (Dering 1999, 2002). The Lower Pecos region houses over 200 rock shelters painted with a vast array of pictographs. These painted images range in age from 4200 years B.P. to after European contact (Boyd 2003; Chaffee et al. 1993; Jackson 1938; Kirkland and Newcomb 1996; Turpin 2004). Of interest, the 4200 year old painting is the oldest directly dated pictograph in North America (Chaffee et al. 1993).

Pecos River style pictographs are the most commonly depicted rock art style in the region. These painted murals often include anthropomorphs, zoomorphs, and a wide range of geometric imagery and enigmatic figures that are not identifiable as human or animal. Many of the anthropomorphic figures are polychromatic, painted with short limbs and elongated bodies, ranging in height from 10 cm to over 8 m (Boyd 2003; Turpin 2004, 2011). Deer and felines are the most common zoomorphic figures depicted in Pecos River style paintings. The majority of deer and feline figures are painted red, but deer have also been found painted in yellow, black, white, or a combination of these colors (Boyd et al. 2014).

In addition to the Pecos River style, four other pictograph styles are found in the Lower Pecos Canyonlands: Red Linear, Bold Line Geometric, Red Monochrome, and Historic (Boyd 2003; Turpin 2004). Red Linear style is characterized by a matrix of attributes, and opposed to Pecos River style anthropomorphs, the figures more closely resemble the human form (Boyd 2003). On average, Red Linear anthropomorphs are 10 cm in height (Boyd et al. 2013). The zoomorphs are frequently executed with exaggerated features, such as absurdly long necks or legs. Enigmatic imagery of the Red Linear style consists mostly of net and snare depictions. Red Linear pictographs, contrary to the name of the style, have been found to be painted in red, black, yellow, and white (Boyd et al. 2013). The Bold Line Geometric style tentatively dates to the Late Prehistoric period (dating after ca. A.D. 500), and is characterized by bold geometric designs including zigzag, lattice, and herringbone patterns (Turpin 1986). Small human- and insect-like forms painted in deep red are the only figures that are not geometric (Turpin 1986). The Red Monochrome pictographs are the most recent of the four major prehistoric rock art styles defined in the Lower Pecos. This style consists of life-size frontally posed human figures wielding bows and arrows, accompanied by realistically depicted animals (Turpin

1984). Historic period rock art depicts horses, crosses, names, dates, missions, and other historic imagery (Boyd 2003).

PREVIOUS RESEARCH AT BLACK CAVE AND BLACK CAVE ANNEX

Black Cave Annex (41VV76a) is located in Seminole Canyon State Park and Historic Site, immediately downstream from Black Cave (41VV76). The rock art imagery at both sites had been previously recorded to varying degrees by Emma Gutzeit and Mary Virginia Carson in 1931 (Emma Gutzeit and Mary Virginia Carson field notes and original paintings, on file at the Witte Memorial Museum), Forrest Kirkland in 1934 (Kirkland and Newcomb 1996), A. T. Jackson in the 1930s (Jackson 1938), David Gebhard in the 1960s (Gebhard 1965), the Texas Archeological Society Rock Art Task Force led by Teddy Stickney in 1993 (Texas Archeological Society Rock Art Task Force records, on file at the Texas Archeological Research Laboratory, The University of Texas at Austin), and most recently by Shumla Archaeological Research and Education Center in 2010 (records on file at Shumla in Comstock, Texas). In addition to rock art recording, Mark Parsons conducted a small, shallow test excavation in 1962, but few undisturbed deposits were found at the site due to previous looting and flooding, particularly from the flood of 1954 (Parsons 1962). Additional work at Black Cave was done in conjunction with Solveig Turpin's survey (Turpin 1982a, 1982b) of Seminole Canyon State Park and Historic Site. Charcoal samples were taken from remnant hearths on the upstream end of the shelter, which yielded conventional radiocarbon dates of 6800 ± 160 years B.P. (TX-4335), 5650 ± 140 years B.P. (TX-4336), and 5500 ± 80 years B.P. (TX-4334) (Turpin 1982a:Table 6).

METHODS

Rock Art Recording

As a part of Shumla's Lower Pecos Rock Art Recording and Preservation Project (Johnson et al. 2011), Black Cave and its Annex were intensively recorded in 2010. At Black Cave Annex, poorly preserved paintings are found on the downstream canyon wall, directly adjacent to the main Black Cave shelter. Black Cave Annex contains Pecos River style pictographs, including a panel painted directly above a small solution cavity (Figure 2). Five impaled deer (three red and two black) form a composition around a central polychromatic Pecos River style anthropomorph. This figure has small single pole ladder-like symbols running parallel to its torso, two darts in its left hand, and a dart-loaded atlatl in its right hand. All of the darts in this composition are fletched and have stylized tips resembling the single pole ladder motif. The dart loaded in the anthropomorph's atlatl is impaling one of the red deer. This deer and three others are facing panel left towards a large accretion on the wall. The fifth deer is positioned to the right of the group and is facing panel right. An enigmatic figure with an antler rack and a diagonal line of paint splatter is located panel right of the anthropomorph, completing the composition. All five deer measure between 35 and 50 cm in length, are impaled with red darts, and have hooves and dewclaws painted on their legs. The artist used controlled strokes to create lines of paint inside of the body, in-filling each of the five deer figures. This technique is

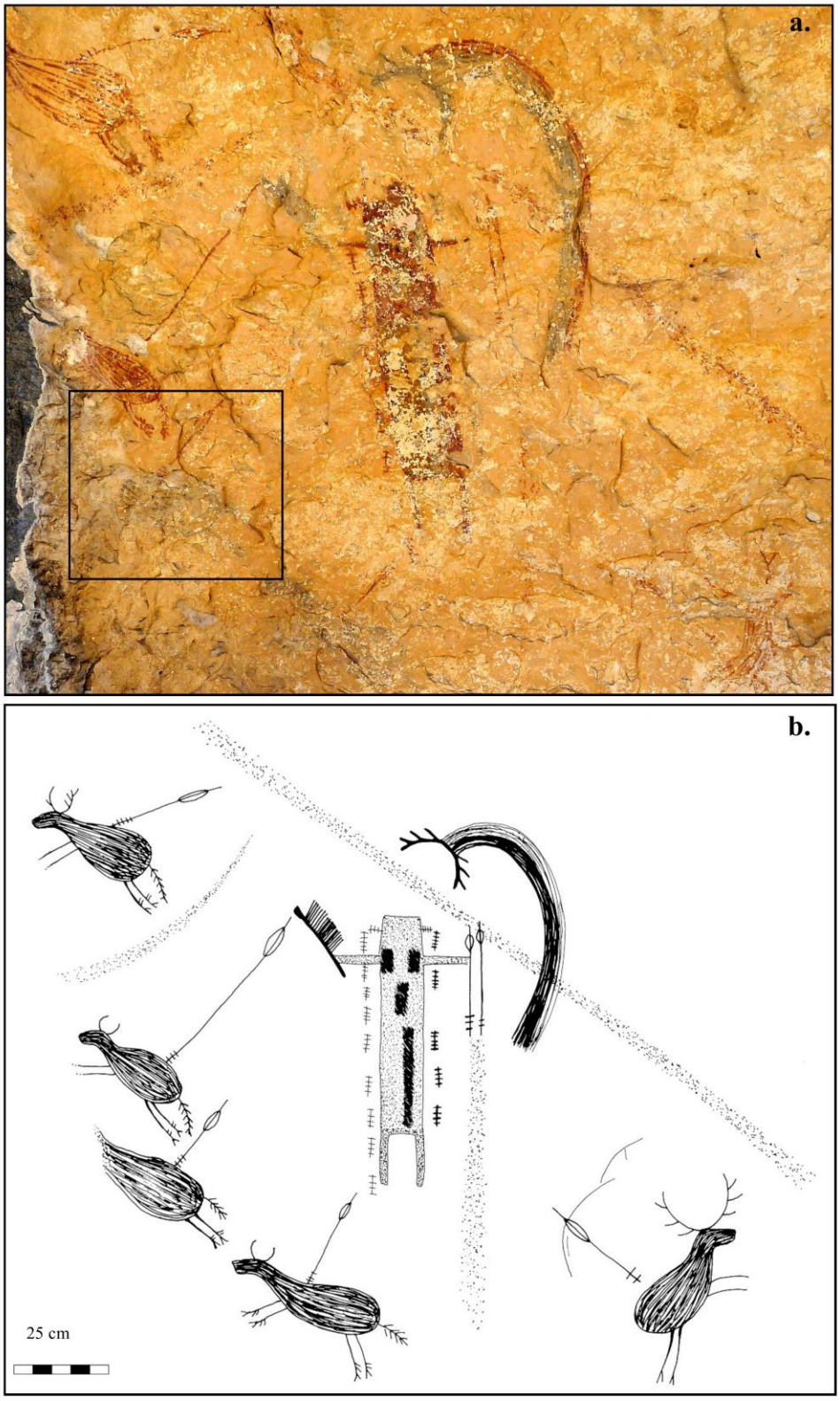

Figure 2. Pecos River style composition at Black Cave Annex (41VV76a). Deer sampled for radiocarbon dating (motif Z011) is outlined: (a) photograph; (b) artist rendition copied from Kirkland and Newcomb (1996).

commonly employed within the corpus of Pecos River style imagery. All of the figures within the composition appear to be painted on the same rock surface with the same red and black pigments. In a concurrent study, Koenig et al. (2014) used a portable X-ray fluorescence spectrometer to confirm that all black Pecos River style paintings, including the black deer dated in this study, are composed of manganese pigment.

Sample Collection

During a site visit, Steelman noted that one of the black deer (motif Z011) contained several fragile pieces of rock substrate that would soon exfoliate from the wall (Figure 3). Because these fragments contained pigment, we selected this figure for radiocarbon dating with permission from Seminole Canyon State Park and Historic Site. The sample consisted of a rock spall containing black pigment from the body of the deer. The collected spall was located at the point where the red dart entered the body. Prior to sampling, all figures were documented with photographs, descriptions, and drawings. Photographs of sampling locations were taken before and after collection (Figure 4). Individual sterile surgical scalpel blades were used to collect the paint sample from a surface area on the order of ~2-3 cm^2. A background sample of unpainted rock substrate was also collected as a control. The paint and background samples were stored in folded aluminum foil squares and placed in labeled plastic bags until the commencement of laboratory analysis. To avoid modern contamination, latex gloves were worn during sample collection and later in the laboratory during any handling of samples.

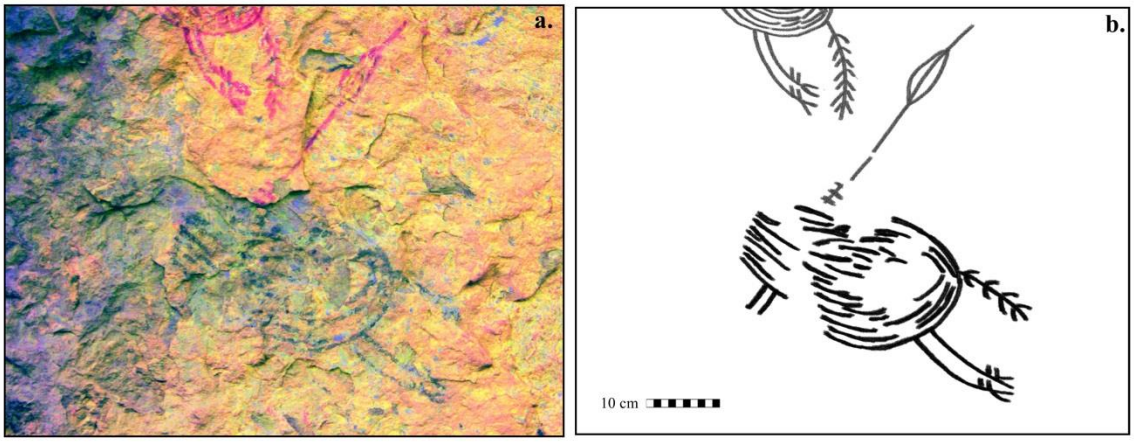

Figure 3. Close-up of motif Z011 prior to sample collection: (a) photograph; (b) illustration. The photograph has been enhanced using D-Stretch with the ybk color channel (Harman 2014).

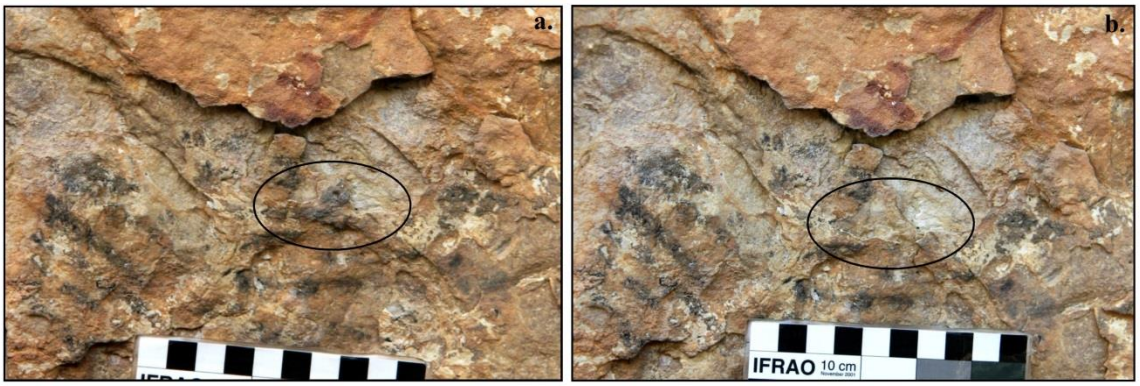

Figure 4. Photographs of the sample location (a) before and (b) after collection. Circle indicates location of collected spall.

Chemical Pretreatment

Before plasma oxidation, the paint and background samples were subjected to chemical pretreatment to remove potential humic acid contamination. Humic acids, naturally present in soil samples and derived from the decay of organic matter, appear brownish-orange in a basic solution. From our experience, the presence of humic acids is minimal for paint samples collected on rock substrates.

For sample preparation, we used a mortar and pestle to powder the collected paint and rock specimens. We examined the samples at 40X magnification to remove any visible contaminants such as fibers, hair, rootlets, or spider webs with micro-tweezers. Two black fibers were found in the paint sample and three black fibers were found in the background sample. All fibers were removed prior to analysis; they were unfortunately too small to date separately.

After removing visible contaminants, both the paint sample and background sample underwent chemical pretreatment. During this process, the samples were weighed and placed into sterile, plastic centrifuge tubes with 3 mL of dilute (1.0 Molar) sodium hydroxide solution. These tubes were set into an ultrasonic water bath at 50 ± 5°C for one hour. Then, the samples were centrifuged for 15 minutes. The liquid above both samples was colorless and transparent, indicating that no humic acids were present. After decanting the basic liquid, 4 mL of distilled, de-ionized water was added to both tubes, which were placed into an ultrasonic water bath at 50 ± 5°C for another hour. The tubes were then centrifuged, the liquid was decanted, and the solid samples were stored in distilled, de-ionized water. We used vacuum filtration with a water aspirator to collect the solid samples onto previously baked (500°C) quartz-fiber filters. The filters were dried in an oven at 110°C, wrapped in aluminum foil, and stored in a desiccator.

Plasma Oxidation and AMS Radiocarbon Measurement

Our laboratory at the University of Central Arkansas (UCA) employed a custom-built plasma oxidation apparatus to convert organic material in this paint sample to carbon dioxide for accelerator

mass spectrometry (AMS) radiocarbon dating. The apparatus, routinely kept under vacuum at a pressure of $\leq 1x10^{-6}$ torr, utilized ultra-high purity (UHP, 99.999 percent) oxygen and argon gases to minimize contamination. We cleaned the apparatus sample chamber by igniting successive oxygen plasma reactions at 1 torr oxygen gas and 100 or 150 watts radio frequency power for one hour each. These cleaning oxygen plasma reactions removed any organic material on the inside of the chamber introduced by previous samples or modern contamination from handling.

Next, we loaded the sample into the chamber. Argon gas was blown through the apparatus creating a positive pressure that prevented atmosphere from entering the instrument. We ignited successive argon plasma discharges, at 1 torr and 40 watts radio frequency power for one hour, to remove adsorbed gases by impinging on the surface of the sample. Argon was used because it is an inert gas and will not chemically react with the sample.

Finally, the sample was oxidized with oxygen plasma gas at a pressure of 1 torr and 100 watts radio frequency power. The organic material in the sample was converted into carbon dioxide and water during the one hour exposure. This same process was carried out on the background sample to ensure that organic contamination in the rock substrate was not significant. For the paint sample, product carbon dioxide and water were flame-sealed into a glass tube cooled to liquid nitrogen temperature (-196°C). The collected glass tube was sent to the Center for Accelerator Mass Spectrometry (CAMS) at Lawrence Livermore National Laboratory for graphitization and radiocarbon measurement.

RESULTS AND DISCUSSION

The oxidized paint sample from Black Cave Annex contained sufficient carbon for radiocarbon dating. This age result is summarized in Table 2. The $\delta^{13}C$ value was assumed to be -25‰ as no stable carbon isotope measurements were made. Calibration was performed with the OxCal computer program version 4.1 (Bronk Ramsey 2009, 2014) using the IntCal13 calibration curve (Reimer et al. 2013). Although calibrating a single rock art date using only the counting error from the AMS laboratory may provide a falsely narrow calendar age range, Rowe has shown that replicate studies on Lower Pecos rock art (dates from multiple paint samples from the same painting) produce a ± 250 years B.P. variation (Rowe 2004; Steelman et al. in prep.).

Table 2. Radiocarbon results for Pecos River Style Black Deer (motif Z011).

Site	UCA ID	CAMS ID	µg carbon	^{14}C Age (years B.P.)	Calibrated Date (2 sigma cal A.D.)
Black Cave (41VV76)	B156	152885	110	1465 ± 40	470-485 (1.1%) 535-660 (94.3%)

For the background sample, negligible amounts of carbon (<1 µg C) were extracted from the unpainted rock. In addition, Rowe has analyzed numerous rock samples from the Lower Pecos and generally found insignificant amounts of organic carbon on the limestone surface of the canyon walls. Of concern, Black Cave is one of the many sites in this area where kerosene had been used to enhance faded images during photography (e.g., Gebhard 1960; Greider 1965). If kerosene contamination had been present on the rock surface, we would have obtained an age much older than observed. For

example, Chaffee et al. (1994) dated a kerosene treated sample in Utah and obtained a radiocarbon result of 32,900 ± 900 years B.P. (AA-8747). However, with such a young age for the black deer, there is no evidence of kerosene contamination.

The black Pecos River style deer from Black Cave Annex was chosen for radiocarbon dating because a portion of the image was becoming detached from the shelter wall. By removing the sample we did no more harm to the pictograph than would have been done from natural weathering. Obtaining radiocarbon samples from pictographs is not always this easy. We must decide between selecting locations that will not further damage the art or locations that answer a specific archeological research question. It is desirable when these circumstances coincide, but often times one is sacrificed in favor of the other. In this case, we took advantage of a deteriorating pictograph in order to expand our knowledge about the temporal range of the Pecos River Style.

While the AMS radiocarbon age of 1465 ± 40 years B.P. is only one new measurement, the result is intriguing. However, as so often happens, we have created more questions than answers:

- Is our single radiocarbon date for the black deer incorrect due to inhomogeneous contamination across the rock surface?
- Are all the figures in the composition the same age?
- Did the Pecos River style endure for a longer time period than previously thought?

CONCLUSIONS

We determined a single radiocarbon age of 1465 ± 40 years B.P. for a painting of a black deer at Black Cave Annex in the Lower Pecos Canyonlands. This is the first radiocarbon result for a Pecos River style deer. Although this new assay is younger than the previously accepted age for the style, we maintain that this deer is Pecos River style based upon artistic execution, relative size, pigment similarity, and overall compositional aspects.

With six other Pecos River Style dates that fall outside of the expected age range for the style, this younger result for the black deer at Black Cave is put into context (Rowe 2004, 2005; Steelman et al. in prep.). If this had been the only younger result for the style, we would have most likely dismissed it as a laboratory outlier. Instead, it has caused us to revisit previous results to conclude that there is either a problem with the dating or our interpretation of the data. If these younger dates are correct, then the currently defined Pecos River style was produced in the Lower Pecos for over 2500 years. In order to understand the chronology of Lower Pecos Canyonlands rock art, it is critical that we obtain more radiocarbon dates so that we may answer some of the questions posed by this study.

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