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INTRODUCTION

In this article, we present the findings of stable isotope analysis (carbon, nitrogen, and oxygen) from an analysis of human remains from a burial at the Pipe site (41AN67). The Pipe site is a late 15th-mid-16th century Caddo settlement and cemetery in the Lake Palestine area in the upper Neches River basin in East Texas that was investigated by Buddy Calvin Jones in 1968 and Southern Methodist University in 1969.

INFORMATION ON THE PIPE SITE

Buddy Jones identified and investigated the Pipe site (41AN67) in 1968. The site was on a low terrace or lower toe slope on the west side of the Neches River valley, and a photograph taken by Jones at the time showed the site area in a pasture, with a tree-covered floodplain to the north and east. The Pipe site had a substantial midden deposit as well as a cemetery with 21 burials (Figure 1).

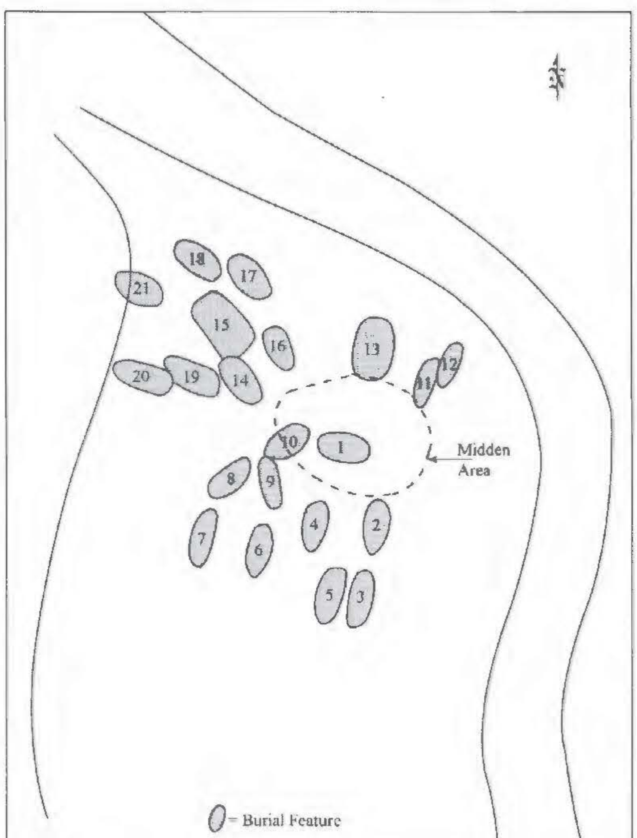

Figure 1. Map of the Pipe site redrawn from a Buddy Jones map on file at the Gregg County Historical Museum.

In 1969, a year after this site had been excavated by Buddy Calvin Jones, Southern Methodist University conducted their own excavations at the Pipe site (which they called the Ferguson site since they were unaware of the Jones excavations) before the construction of Lake Palestine (Anderson et al. 1974:121-134). Their work was concentrated in a midden deposit near the northeastern extent of the landform (in the same area of the landform depicted in Jones' map, see Figure 1). No Caddo burials were identified during the SMU work, not too surprising given that the cemetery with 21 Caddo burials had been completely excavated a year or more before. No habitation features were documented in the SMU excavations, again not surprising in that the midden was an area of trash deposits and habitation features (i.e., pits and post holes from domestic structures) would be expected to not occur in the midden, but in general proximity to, but outside of, the trash midden itself. SMU's archaeological investigations rarely strayed from the midden (Anderson et al. 1974:Figure 58).

What was recovered at the Pipe/Ferguson site was an abundance of Frankston phase ceramic vessel sherds (n=7964, including Poynor Engraved, Hume Engraved, Maydelle Incised, Bullard Brushed, Killough Pinched, and LaRue Neck Banded) and ceramic pipe sherds (n=43), mussel shell fragments and animal bones, and a modicum of chipped stone tool artifacts. The latter included 16 arrow points and fragments (of the Perdiz type), 13 flake tools and scrapers, and only 297 pieces of lithic debris.

There are two radiocarbon dates from the Pipe/Ferguson site (Perttula 1997:Table 1), both obtained from the SMU excavations (Anderson et al. 1974), which is believed to be the same site as the Pipe site investigated by Buddy Calvin Jones. Both dates are on a wood post fragment buried in the midden deposits. These dates, using IntCal09 (Reimer et al. 2009) to calibrate their conventional ages, have calibrated age ranges at 2 sigma (95% probability) of A.D. 1529-1683 (Tx-1275) and A.D. 1444-1644 (Tx-1276). If these two calibrated age ranges accurately capture the temporal extent of the Caddo occupation, then it would appear that the site was occupied through most of the 16th and 17th century A.D. The mean calibrated age range of these dates is A.D. 1487-1663.

A seriation of ceramics from Early to Historic Caddo period sites developed for the upper Neches River/Lake Palestine area, indicates that the Pipe/Ferguson site more likely dates to the middle part of the Frankston phase (Perttula 2011a:Table 2). This group of sites has been estimated to date between ca. A.D. 1480-1560 (Perttula 2011b). As mentioned above, the mean age of the two calibrated radiocarbon dates from the Pipe/Ferguson site is A.D. 1487-1663. This mean age is in agreement regarding the estimated initial occupation of the site taking place around the 1480s, but there is a broad divergence on when the end of the Caddo occupation dates to, either A.D. 1560 from the ceramic seriation data or the A.D. 1660s from the calibrated radiocarbon age ranges. Given the absence of Patton Engraved pottery sherds from the Pipe/Ferguson site (Anderson et al. 1974:Table 40), and an abundance of Poynor Engraved fine ware sherds in the assemblage, it is doubtful that the Caddo occupation here could have lasted as late as ca. A.D. 1650 (the beginning of the heyday of Patton Engraved manufacture and use), but how much earlier than that is unknown. Simply on the basis of the seriation results, it is conjectured that the occupation at the Pipe site/Ferguson site ended closer to ca. A.D. 1560 than it did to ca. A.D. 1650.

RESULTS OF THE STABLE ISOTOPE ANALYSIS

The human remains sampled from the Pipe site were described in a previous study (Wilson 2006). They represented the remains of an adult male described in the Buddy Jones collection as Lot 29, B-11 Skull No 2, suggesting it was part of a multiple burial in the cemetery. Because the individual was represented by only a right femur, dietary reconstruction was not possible at the time of initial analysis.

This study uses stable isotopes as a means to reconstruct the diet for the individual recovered from the Pipe site in the Buddy Jones collection. A sample of the right femur was sent to the Bone Chemistry Laboratory, Department of Anthropology, at the University of Florida, Gainesville, where the sample was prepared and processed. Results were provided for $\delta^{13}C$ on collagen and apatite, $\delta^{15}N$ on collagen, and $\delta^{18}O$ on apatite.

Carbon stable isotopes are used to examine dietary sourcing, ultimately for plants that utilize different photosynthetic pathways: C_3 C_4 and CAM. All trees, woody shrubs, herbs, and temperate shade-loving grasses are C_3 plants. Prior to the introduction of maize, Caddo food resources were C_3-based. The $\delta^{13}C$ values of C_3 plant resources have an assumed average of -26.5‰, while C_4 plants average -12.5‰ (Tieszen 1991; Ambrose 1993). CAM (Crassulacean Acid Metabolism) plants are mostly succulents and have $\delta^{13}C$ values that overlap C_3 and C_4 plants. They are not discussed in this article due to their lack of dietary contribution to Caddo diets. Nitrogen isotope ratios provide information about the trophic level and protein sources in the diet. Nitrogen isotopes are useful in discerning aquatic versus terrestrial components of the diet. Humans in terrestrial-based food webs typically have $\delta^{15}N$ values of 6-10‰, whereas consumers of fish may have $\delta^{15}N$ values that range as high as 15-20‰ (DeNiro and Schoeninger 1983; Hard and Katzenberg 2011). By convention, stable isotope ratios are expressed in the δ notation, in parts per thousand, read as ‰, relative to an international standard. For carbon the standard is the marine limestone PDB and for nitrogen it is what we refer to as AIR.

Collagen is the main protein in bone and dentin that provides the source for organic carbon. It is less subject to isotopic substitution than apatite, the mineral portion of bone. Controlled diet studies on animals show that bone collagen primarily reflects the protein dietary carbon source while apatite reflects the whole diet (Ambrose and Norr 1993; Tieszen and Fagre 1993; Jim et al. 2004). The collagen enrichment factor is the difference between the dietary and bone signature for carbon and is approximately 5‰ (van der Merwe and Vogel 1978; Sullivan and Krueger 1981; Lee-Thorpe et al. 1989). Apatite enrichment is assumed to be around 9.5‰ (Sullivan and Krueger 1981; DeNiro and Schoeninger 1983).

Oxygen isotopes are used for geographic origin determination and are affected by latitude, regional topography, and weather patterns. Delta ^{18}O decreases with distance to the earth's poles and increases with humidity in the local environment. To date, little use of oxygen isotopes has occurred in the Caddo archaeological region.

The results of the stable isotope testing are presented in Table 1. The $\delta^{13}C$ collagen result is higher than the mean for Late Caddo period sites in the Neches and Angelina River basins presented in Perttula et al. (2011) and raises the regional mean slightly (Table 2). This indicates a significant contribution of C_4 to the protein portion of the diet in the Pipe site male tested. During the Late Caddo period, there is significant variability in $\delta^{13}C_{collagen}$ values within and between sites. The Pipe site result falls within the standard deviation for the region and period.

Table 1. Stable isotope results for Lake Palestine, Lot 29 B-11, Skull 2 at the Pipe Site (41AN67).

Collagen yield	Percent collagen	C/N	$\delta^{13}C$ collagen ‰	$\delta^{15}N$ collagen ‰	$\delta^{13}C$ apatite ‰	$\Delta^{13}C$ apatite-collagen	$\delta^{18}O$ apatite ‰
0.0485g	0.00375	3.2	-13.20	7.02	-6.35	6.85	-9.50

Table 2. Late Caddo period Neches and Angelina River basins stable isotope data. Except data from the Pipe Site, all data from Perttula et al. (2011).

Site name	Site	δ13C collagen ‰	δ13C apatite ‰	δ15N collagen ‰
Pipe	41AN67	-13.20	-6.35	7.02
Lang Pasture	41AN38	-15.6	-9.2	9.7
Lang Pasture	41AN38	-18.7	-10.2	-
Lang Pasture	41AN38	-19.5	-9.7	-
Lindsey Park	41SM300	-21.8	-	-
Emma Owens Farm	41AN21	-13.9	-6.8	6.3
EW Hackney	41CE6	-12.8	-6.7	2.8
EW Hackney	41CE6	-	-7.4	8.9
JW Blackburn	41CE4	-	-7.7	-
JW Blackburn	41CE4	-9.7	-7.6	-
OL Ellis Farm	41AN54	-	-8.1	13.7
OL Ellis Farm	41AN54	-	-7.4	12.4
EW Henry Farm	41CE17	-13.3	-12.1	-
Fred McKee	41AN32	-12.2	-4.8	10.4
AH Reagor Farm	41CE15	-14.9	-	10.8
AH Reagor Farm	41CE15	-13.3	-6.7	-
Pierce Freeman Farm	41AN34	-14.8	-9.1	13.2
Lang Pasture	41AN38	-19.7	-8.7	-
Mean		-15.24	-8.03	9.52
Standard deviation		3.43	1.76	3.40

Like δ13C collagen, the δ13C apatite value is higher than the mean for the Late Caddo period in the Neches and Angelina River basins, but falls within the standard deviation for the time period. This result indicates that the individual from the Pipe site consumed more C4 dietary resources than the average for the region. Using Ambrose et al.'s (1997, 2003) formula, C4 contributed an estimated 62% of the dietary resources consumed by the tested individual at the Pipe site. In comparison, the average consumption of C_4 for Caddo individuals in the Neches and Angelina River basins from the Late Caddo period is 50%.

Nitrogen isotope values from the Pipe site individual were low compared to the mean for the region and time period (see Table 2). The $\delta^{15}N$ values for the region in the Late Caddo period are highly variable, indicating differences in protein resources, ranging from primarily beans to fish. The relatively low trophic value indicated by the $\delta^{15}N$ value combined with the relatively high $\delta^{13}C$ collagen and apatite values indicate a higher contribution of maize to the diet of the Pipe site individual than seen in most other Caddo individuals from the region.

CONCLUSIONS

In this study stable isotope testing has been used to reconstruct the diet for a Late Caddo period individual from whom only postcranial remains were present. In cases such as this, where teeth are lacking, stable isotope studies provide the only, as well as the most direct, method for determinations of diet.

With the use of stable isotope analysis we have been able to place the individual from the Pipe site into a regional context that shows a relatively varied diet, particularly in terms of protein sources. While the individual tested had a reasonably high contribution of maize to his diet, Figure 2 shows that he fits well within a small cluster of other individuals from the Late Caddo Neches and Angelina River basins. This cluster of four consists of adults from different sites: two males, one female, and one of indeterminate sex. Results are consistent with an intensified maize agricultural diet.

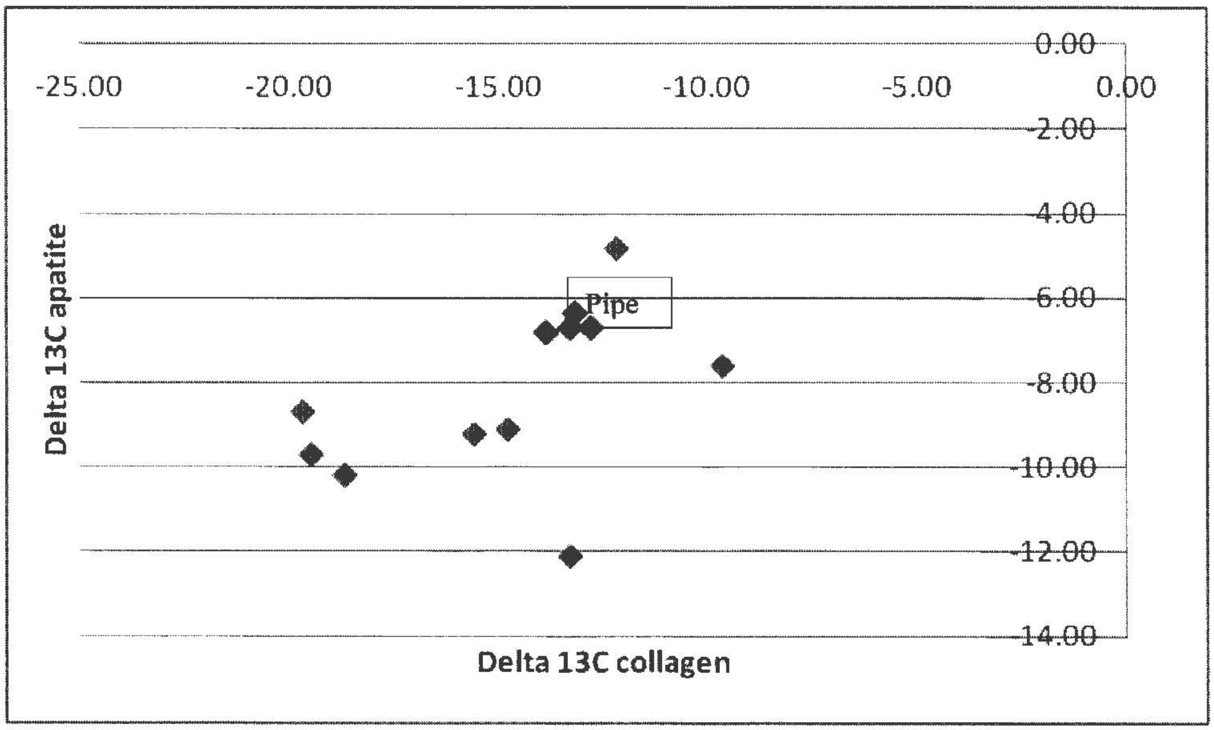

Figure 2. $\delta^{13}C_{apatite}$ plotted against $\delta^{13}C_{collagen}$ for the Late Caddo period Neches and Angelina River basins.

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