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Ancient Native American bone tattooing tools and pigments: Evidence from central Tennessee

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ABSTRACT

Analyses of archaeological bone tool assemblages from the southeastern United States rely principally on morphological classification systems to delineate typologies and infer artifact function. Under these systems the actual purpose of pointed bone artifacts generically classified as "awls" is frequently overlooked. In this study we move beyond basic morphological classification by combining zooarchaeological analysis, technological assessment, use-wear analysis, and materials science studies to examine an assemblage of bone tools from an ancient Native American site in central Tennessee. Our analysis reveals that approximately 3500–1600 BCE, occupants of the Fernvale site employed sharpened turkey (*Meleagris gallopavo*) bone tools as tattooing implements, and that both red and black pigment remains are directly associated with these artifacts. These materials comprise the earliest directly-identified tattooing tools to date, and demonstrate the persistence of Native American tattooing in southeastern North America over at least three millennia.

1. Introduction

The First American inhabitants of the southeastern United States arrived during the late Pleistocene, carrying with them the region's earliest bone tool technologies (Dunbar and Webb, 1996). The archaeological record of the ensuing 14,000+ years is replete with artifacts of Native American osseous tool industries. Archaeological studies of both individual bone tools and tool assemblages from the American Southeast principally rely on morphological classification to delineate typologies and infer the presumed functions of those artifacts. As a result, thousands of sharpened bone implements have been generally lumped under the type category of "awls," regardless of their specific physical characteristics or archaeological context. Morphological classifications are broadly useful in delineating artifact typologies for osseous tools. However, modern bone tool analysis (Gates St-Pierre, 2007, 2010; Gates St-Pierre and Walker, 2007) and region-specific use wear studies (Bader, 1992; Byrd, 2011) demonstrate that gross tool morphology is of limited utility in determining the actual function(s) for which sharpened bone artifacts were employed.

We report here the findings of a study combining zooarchaeological analysis with microscopy, elemental analysis, and contextual assessments of a group of sharpened bone tools from the Fernvale site, a multicomponent ancient Native American habitation and mortuary location in central Tennessee. These artifacts are crafted from turkey (*Meleagris gallopavo*) leg bones, and date to the Archaic period of the regional archaeological sequence, ca. 3500–1600 BCE. Distinctive use-wear patterns identified on two of the sharpened turkey tarsometatarsii demonstrate these artifacts were used to tattoo. Microwear and contextual analysis of two associated turkey radii suggests they acted as pigment applicators. Examination of pigment residues with portable X-ray fluorescence spectroscopy (pXRF) allows us to describe the composition of red earth pigments associated with these artifacts.

Body marks depicted in ancient art from North America's Eastern Woodlands suggest Native American tattooing traditions in the region extend to the first centuries CE. However, the actual time depth and material culture of those practices, including the associated tools and pigments, remain poorly understood. The findings presented here extend the date of Native American tattooing in the region by over a

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millennium, and reiterate the importance of employing multiple lines of evidence in bone tool analysis.

2. Archaeological background and context

2.1. The Fernvale site

The Fernvale archaeological site (trinomial 40WM51) is a multi-component ancient Native American habitation and mortuary location situated along a first stream terrace of the South Harpeth River in central Tennessee (Fig. 1) (Text S1). Temporally-sensitive artifacts and radiocarbon data from the site reveal an occupation sequence spanning more than 7,000 years, with major occupations originating in the Late Archaic (ca. 3000–1000 BCE), Middle Woodland (ca. 300 BCE–300 CE), and Mississippian (ca. 1000–1500 CE) periods (Deter-Wolf, 2013b). The complete site record therefore broadly encompasses culture shifts from forager societies of the Archaic period, through Woodland period horticulture and permanent year-round site settlement, culminating with intensive agriculture and complex regional political organization in the Mississippian period.

Woodland and Mississippian period occupations at Fernvale include single-family structure footprints, the latter dated ca.1026–1262 cal CE (Steere and Deter-Wolf, 2013). No structure footprints are associated with Archaic occupations at Fernvale or other contemporaneous sites in the region. Instead, the Archaic sequence consists of an array of more than 30 pit features, some of which contained partially- to fully-flexed human burials (Deter-Wolf et al., 2013; Hodge and Davis, 2013). Herein we describe analysis of six osseous tools recovered from Feature 94, a Late Archaic mortuary feature.

2.1.1. Feature 94

Feature 94 at the Fernvale site was a roughly circular pit measuring approximately 1 m in diameter, which contained the flexed burial of a probable adult male estimated at 25–55 years of age and identified as Burial 24 (Text S1) (Hodge and Davis, 2013). In addition to materials recovered from the general feature matrix, Feature 94 included a discrete cluster of artifacts situated adjacent to the individual's upper spine, within an area measuring approximately 23 × 25 cm (Fig. 2). The artifact grouping included lithics, vertebrate and invertebrate remains (Text S1; Table S1), and indications of degraded red ochre pigment. That deposit was originally recorded by excavators as a "toolkit," although no specific functional role was suggested. Deter-Wolf and Peres subsequently reassessed these materials and interpreted them as the remains of a cache or bundle of artifacts held within multiple biodegradable wrappings (Deter-Wolf and Peres, 2019).

The present study examines six turkey (*Meleagris gallopavo*) bone tools from Burial 24. Three sharpened left turkey tarsometatarsii designated artifacts A24, A25, and A26, were arranged immediately alongside one another in the western portion of the artifact cluster, with distal ends aligned northwest (see Fig. 2). These artifacts included two complete specimens (A24, A25) and one incomplete specimen (A26) (Fig. 3). The two complete tools measure 101 (A24) and 107 (A25) mm in length. All are sharpened on their distal ends, and artifact A26 exhibits an incomplete proximal epiphysis. The orientation and position of these artifacts relative to one another suggests they were originally held within a discrete biodegradable wrapping separate from the surrounding materials.

A fourth turkey tarsometatarsus (A27) was situated separately within the artifact cluster (see Fig. 3). It includes the shaft only, and is sharpened proximally. The medullary cavity of this artifact is exposed along its entire length, and much of the distal tip has been lost to breakage.

Two right turkey radii designated artifacts A28 and A29 were oriented across the center of the artifact grouping (Fig. 4; see Fig. 2). The longer of these tools (A28) measures 109 mm and has an average shaft width of 5.8 mm. The shorter radius (A29) measures 86 mm in length, and has an average shaft width of 4.2 mm. Both radii are obliquely-cut at angles of 22.5–23 degrees, and exhibit polish development along the cut surfaces.

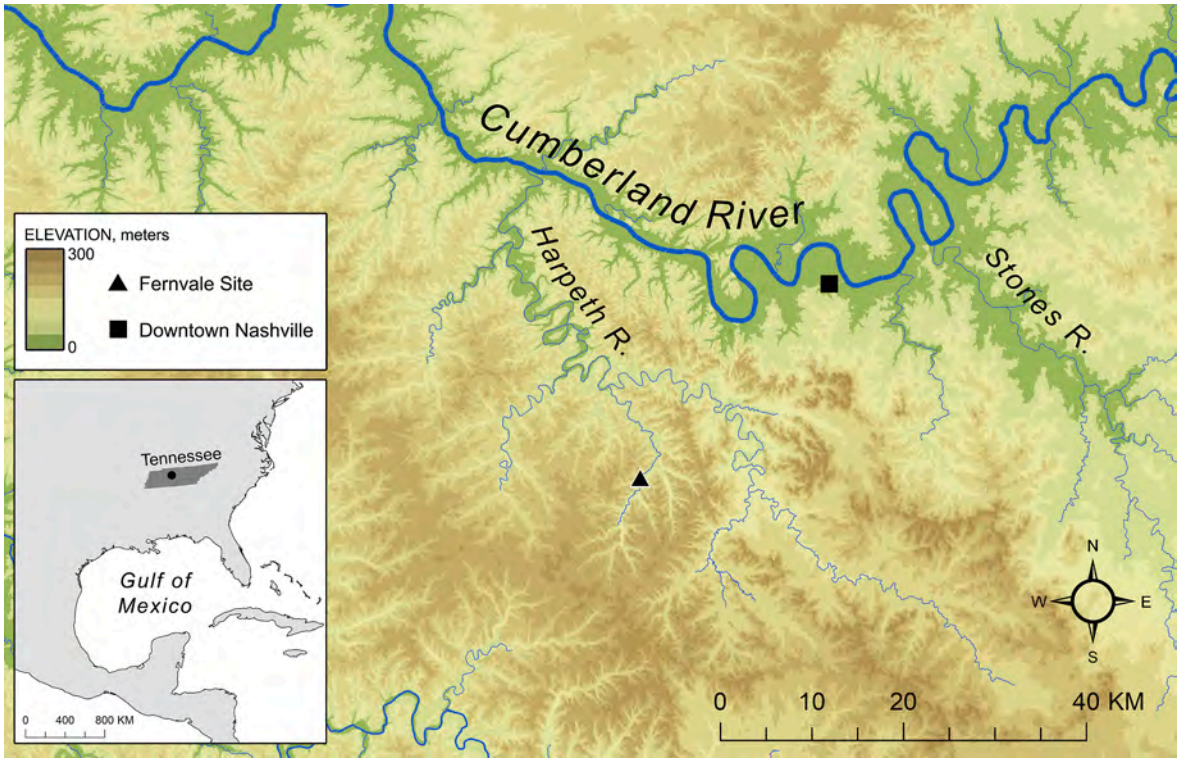

Fig. 1. Location of the Fernvale archaeological site. The Fernvale archaeological site (trinomial 40WM51) is situated along the South Harpeth River, a tributary of the Cumberland River, in central Tennessee.

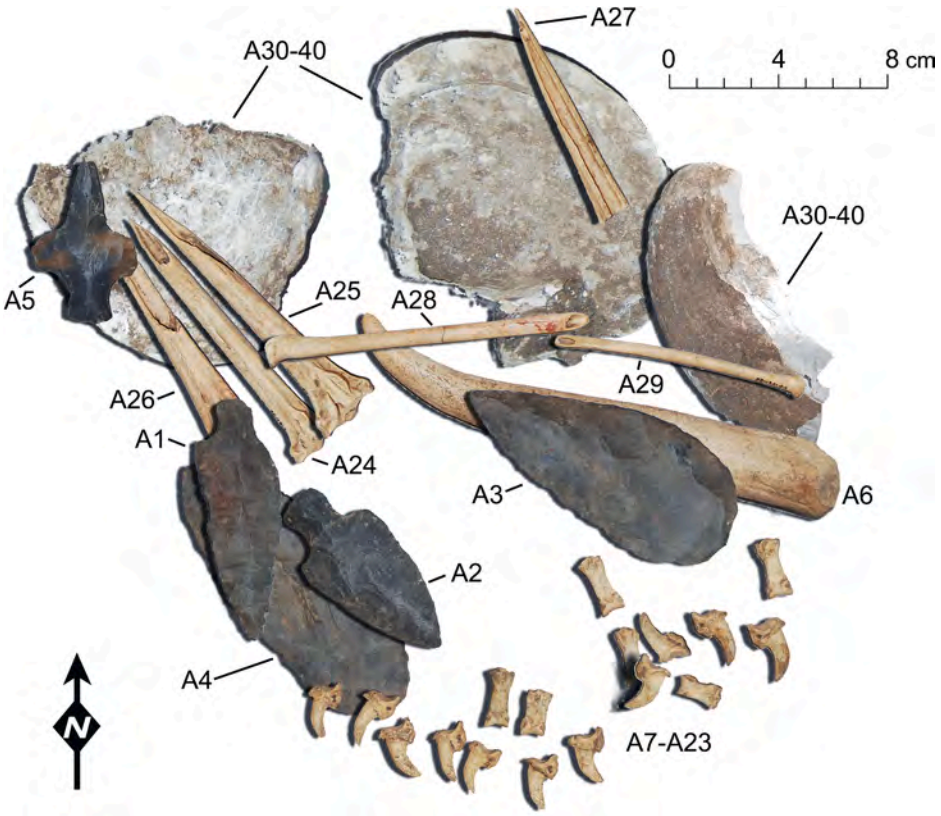

Fig. 2. Digital reconstruction of the artifact cluster from Feature 94/Burial 24 at the Fernvale site, Tennessee. This reconstruction was generated using digital photographs of individual artifacts, and based on *in situ* documentation including original excavation notes, field drawings, and 35 mm slide film.

Fig. 3. Sharpened turkey (*Meleagris gallopavo*) tarsometatarsii (all lefts) from Feature 94/Burial 24 at the Fernvale site, Tennessee. The two complete artifacts (A24 and A25) exhibit microwear on their tips consistent with use as tattooing implements.

2.1.2. Dating

An initial age estimate of 2000–1600 BCE was proposed for Burial 24 based on lithic biface morphology and overall site chronology. Lithic materials present in the Burial 24 artifact cluster included two stemmed bifacial spear points or knives (see Fig. 2, artifacts A1 and A2; Text S1; Table S1). Those artifacts have unground bases and alternately exhibit a straight stem with rounded base and asymmetrical blade (A1), and an expanded stem with flat base and excurvate blade (A2). The overall morphologies of these two bifaces do not fit neatly within named projectile point type categories for the American Southeast, but are broadly diagnostic of dated contexts from the Late Archaic through the Early Woodland periods, ca. 3000–200 BCE (Tune and Deter-Wolf, 2013). Within the overall site assemblage, diagnostic artifacts and radiocarbon dates show major Archaic occupations took place during the earlier portion of that sequence, prior to about 1600 BCE (Deter-Wolf, 2013b).

The initial age estimate for Burial 24 was revised following radiocarbon AMS dating of a naturally-fragmented piece of freshwater bivalve from the artifact cluster by Beta Analytic of Miami, FL. That 0.5 g sample was recovered from among numerous small, exfoliated shell fragments present in the original artifact storage bag. The sample returned a range of 3516–3368 cal BCE (Beta-477342; 95.4% probability; 4660 +/- 30 14C yr BP; calibrated with IntCal20 in OxCal 4.4 [Bronk Ramsey, 2009; Reimer et al., 2020]).

The "old wood" or "old shell" effect describes situations wherein the actual age of a material may be older than its archaeological context (Rick et al. 2005). A possible example of this issue appears elsewhere at the Fernvale site in Feature 71, a non-mortuary pit feature that contained a gorget made from the outer whorl of a marine lightning whelk (*Busycon sinistrum*), deposited atop 52 marine shell beads. The gorget was AMS dated 4446–4336 cal BCE, while an associated disc bead returned a range of 2201–1984 cal BCE Deter-Wolf, 2013b; recalibrated with IntCal20 in Oxcal 4.4 [Bronk Ramsey, 2009; Reimer et al., 2020]). Based on these ages, it appears that the gorget was either fashioned from

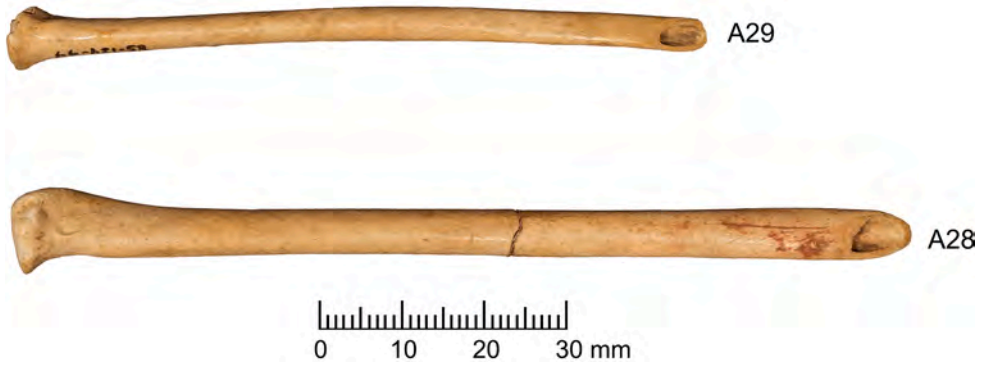

Fig. 4. Cut turkey (*Meleagris gallopavo*) radii (both rights) from Feature 94/Burial 24 at the Fernvale site, Tennessee. Both are obliquely-cut at angles of 22.5–23 degrees, and exhibit polish development along the cut surfaces.

much older shell than the associated beads, or perhaps curated from an earlier archaeological setting (Deter-Wolf and Peres, 2014). In the case of the artifact cluster from Fernvale Burial 24, it is possible that the sampled freshwater shell predates the associated artifacts, or even the burial itself.

The second consideration with direct dating of the Fernvale Burial 24 materials via molluscan remains concerns the freshwater reservoir effect (FRE). Shellfish and other aquatic species consume carbon from reservoir environments which may exhibit different concentrations than are found in the atmosphere, and therefore may antedate results from contemporaneous terrestrial samples (Philippsen, 2013). No localized FRE correction exists for the Cumberland River Valley or the tributary Harpeth River, and so no correction has been applied to the radiocarbon date reported above. It is therefore possible that the actual date for Burial 24 at the Fernvale site is several centuries older than the reported radiocarbon range. With these various factors in mind, we conservatively estimate the age of Fernvale Burial 24 at 3500–1600 cal BCE.

2.2. Studies of tattooing artifacts

Tattoos preserved on mummified human remains demonstrate the global antiquity of tattooing extends to at least 3200 BCE (Deter-Wolf et al., 2016; Deter-Wolf, 2019). There are nevertheless few conclusive archaeological identifications of either the tools or pigments used for tattooing among ancient societies. Exceptions are found predominantly in the Pacific Islands, where distinctive morphological attributes of multi-toothed bone and shell tattooing combs provide a definitive means of direct historical comparison for archaeological materials dating back to at least 800 BCE (Clark and Langley, 2019; Kirch et al., 1995; Molle and Conte, 2013; Walter, 1998). Use-wear studies from Melanesia demonstrate obsidian implements and ochre pigments were used for skin piercing and/or cutting in that region by ca. 1000 BCE (Kononenko et al., 2016; Torrence et al., 2017). Elsewhere in the world, archaeological identifications of potential tattooing implements have relied primarily on contextual associations between sharpened tools and pigment remains, and the intuition of investigators (e.g., Bohrer 1962; Booth, 2001; Deter-Wolf, 2013c; Friedman, 2017; Krutak, 2017; Yablonsky, 2017; Zidarov, 2017).

Prior identifications of possible tattooing tools in the archaeological record of eastern North America have employed direct historical comparisons and perceived macromorphological traits to suggest tattooing functions for various artifacts, including single and multi-point sharpened bone implements, and various stone tools (e.g. Deter-Wolf, 2013a; Kimball et al., 2010; Knight, 2010; Strezewski, 2003). However, recent application of contextual analysis grounded in ethnographic analogy suggests that gross artifact morphology is of limited utility in securely establishing that a given artifact was used to tattoo (Deter-Wolf et al., 2017). Associations of potential tattooing implements with other specific classes of material culture, particularly pigment remains and items used for processing or applying pigment, provide a more suitable framework for interpreting a possible tattooing function (Deter-Wolf, 2013a, 2013c). It is according to this contextual approach that the artifact cluster from Fernvale Feature 94/Burial 24 was initially proposed to include, at least in part, a possible tattooing toolkit (Deter-Wolf and Peres, 2019).

There are to date only two direct identifications of Native American tattooing tools from archaeological collections. A recent study by Christian Gates St-Pierre (Gates St-Pierre, 2018) codified the specific use-wear signature of bone tool tattooing via experimental replication and testing. That investigation demonstrated that tattooing by hand with single-point osseous tools results in formation of distinctive microwear patterns, including rounding and development of polish within 3 mm of the apical tip. The same study applied these findings to demonstrate that a series of bone implements from the Droulers-Tsiionhiakwatha site, a fifteenth century CE Iroquoian village in southern Quebec, exhibit use-wear signatures comparable to those generated during experimental testing (Gates St-Pierre, 2018). The bone implements from Droulers-Tsiionhiakwatha thereby became the first directly-identified, pre-European contact tattooing implements from North America.

Direct physical examinations were also employed during recent analysis of a cactus spine tool from the Turkey Pen site in southern Utah (Gillreath-Brown et al., 2019). That implement exhibits black, macroscopically-visible staining on the final 2.08 mm of paired cactus spines, but due to its origin within a midden deposit provided no additional contextual data in support of a possible tattooing function. Scanning electron microscopy, portable X-ray fluorescence, and energy dispersive X-ray spectroscopy facilitated identification of botanical materials from which the tool was made, and of the black pigment as likely being carbon-based. Finally, experimental archaeological testing with cactus spine tools demonstrated that the artifact exhibits replicable use-wear consistent with tattooing. Those signatures include stripping of barbed structures, smoothing and rounding of the tips, and embedding of pigment into the spines themselves (Gillreath-Brown et al., 2019). Radiocarbon assays place deposition of the Turkey Pen artifact at 137–215 cal CE, during the Basketmaker II period of regional prehistory.

3. Methods

Documentation and analysis of the bone tools from Feature 94/Burial 24 at the Fernvale site was conducted between 2007 and 2017 at the Tennessee Division of Archaeology (TDOA), Middle Tennessee State University (MTSU), and the Florida State University Department of Anthropology (FSU). Detailed microscopic examinations were performed using a Leica DM750P polarizing microscope with Leica ICC50 Camera Module, and a Dino-Lite AM7915MZTL digital microscope. Artifacts were examined at magnifications of 10X–140X, and wear patterns and manufacturing marks were recorded according to location,

orientation, shape, and type (Bradfield 2015). Assessments of these attributes relied on the authors' previous experimental archaeological work (Deter-Wolf and Clark, 2017; Deter-Wolf and Peres, 2013), as well as comparative studies of bone tool microwear (Buc, 2011; Byrd, 2011; d'Errico and Backwell, 2009; Gates St-Pierre, 2007, 2018; Legrand and Sidéra, 2007). Measurements for manufacturing marks, microwear, and pigment remains were recorded on the Dino-Lite microscope using DinoCapture 2.0 software. Overall tool dimensions were recorded using Mitutoyo Series 500 digital calipers.

Portable X-ray fluorescence (pXRF) spectroscopy was conducted at the Florida Department of State, Division of Historical Resources, Bureau of Archaeological Research. Analysis was performed with a Bruker Tracer III-SD with anode x-ray tube and proceeded in an entirely non-destructive manner. Each measurement was conducted for a 30-second count at 40 kV and 10.7 μA over a surface area measuring approximately 7 mm^2. Analysis focused on artifacts A24 and A28, both of which exhibit macroscopically-visible pigments (see below). During examination the instrument was positioned vertically with artifacts resting above and in direct contact with the sensor.

4. Results

4.1. Manufacturing marks and microwear

Examinations of the bone tools from the Burial 24 assemblage recorded the presence of both manufacturing marks and microwear. Manufacturing marks included evidence for shaving, cutting, and abrading consistent with patterns identified during experimental replication of bone tools by the authors (Deter-Wolf and Clark, 2017; Deter-Wolf and Peres, 2013). Tarsometatarsii A24, A25, and A26 all exhibit manufacturing marks along their shafts comprised of sporadic oblique- to transverse gouges, formed by cutting and shaving with lithic implements during bone procurement and/or tool shaping. Several deep gouges are present on the medullary surface of artifact A24. Where discernable, cut marks appear to traverse from upper left to lower right across the longitudinal axis of the tool shaft. Artifacts A24 and A25 both exhibit clustered light- to medium longitudinal striations indicative of abrasive sharpening within 11 mm of their distal tips.

Both complete tarsometatarsii (A24 and A25) exhibit distinctive microwear at their sharpened ends (Fig. 5). This wear extends approximately 2.83 to 3.26 mm from the apical tips, and is characterized by rounding of the tool tip, development of polish, and flattening of bone fibers which obscures manufacturing marks. No evidence for micro-striations, polish, or other use-wear are present elsewhere on tarsometatarsii A24 or A25. In addition, neither artifact exhibits evidence of spalling, breakage, or pitting either at the tips or along their apical shafts, such as may be generated by working dry hides (see Discussion).

Tarsometatarsus A26 lacks its tip, and exhibits deep gouges approaching the proximal epiphysis, as well as a series of parallel, oblique cut marks between 0.69 and 2.63 mm in length (Fig. S1). Low polish development associated with pigment remains (see below) is present on two surfaces of the proximal epiphysis.

Tarsometatarsus A27 exhibits a rough surface marked by clusters of oblique to longitudinal gouges measuring 4.24 to 7.34 mm in length. These manufacturing marks are indicative of cutting and shaving, and extend along 34 mm of the shaft, in one area reaching within 2 mm of the tool tip. No polish, micro-striations, or other wear signatures are present on artifact A27.

Radius A28 exhibits manufacturing marks consisting of longitudinal to oblique gouges measuring 1.00–18.53 mm long within the initial 30 mm of the tool tip (Fig. S2). Sporadic oblique to transverse gouges <1.9 mm in length are present along the shaft of radius A29. Radii A28 and A29 both exhibit polish across the surface of their obliquely-cut tips, as well as lighter polish extending down their shafts. Polish on the larger radius (A28) reaches approximately 19 mm along the shaft from the tip, while the smaller tool (A29) exhibits polish extending approximately 16 mm down the shaft.

4.2. Pigments

Macro- or microscopically visible pigment residues are present on all examined artifacts except tarsometatarsus A27. Pigment residues on tarsometatarsus A24 are adhered to the surface and found within several gouges and depressions of the medullary surface 2.57–6.70 mm from the tool tip (Figs. 6A and S3). The largest of these deposits covers an area of approximately 1.21 mm^2. On the opposite surface, minute red residues > 0.055 mm^2 are recessed within the surface topography 3.58 mm from the tool tip (Fig. S3). Under magnification pigments on artifact A24

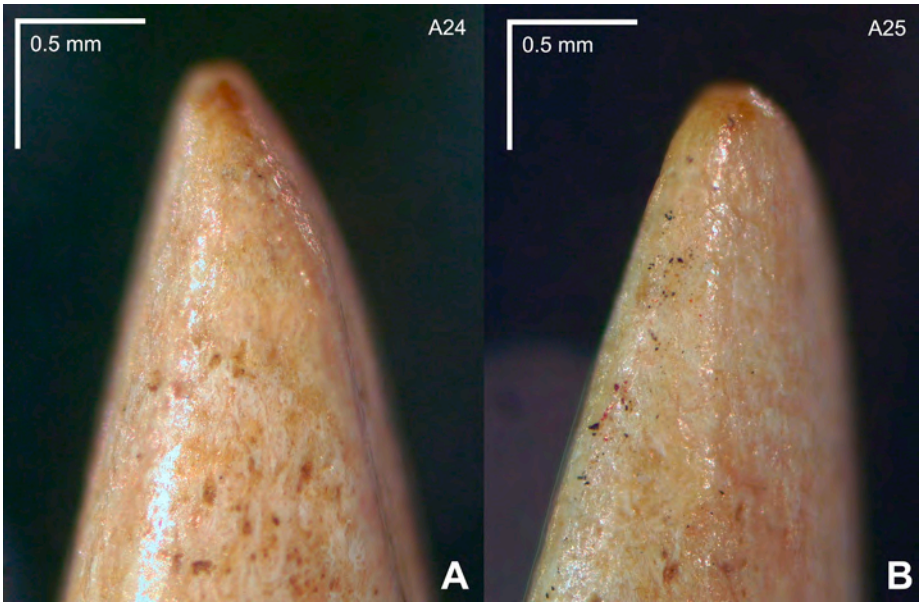

Fig. 5. Tips of sharpened turkey (*Meleagris gallopavo*) bone artifacts A24 (A) and A25 (B) from Feature 94/Burial 24 at the Fernvale site, Tennessee. Both artifact tips exhibit rounding and polish in the final 3.26 mm. (A) Artifact A24 exhibits faint red pigment embedded in surface depressions. (B) Artifact A25 shows minute traces of black and red pigment as surface deposits.

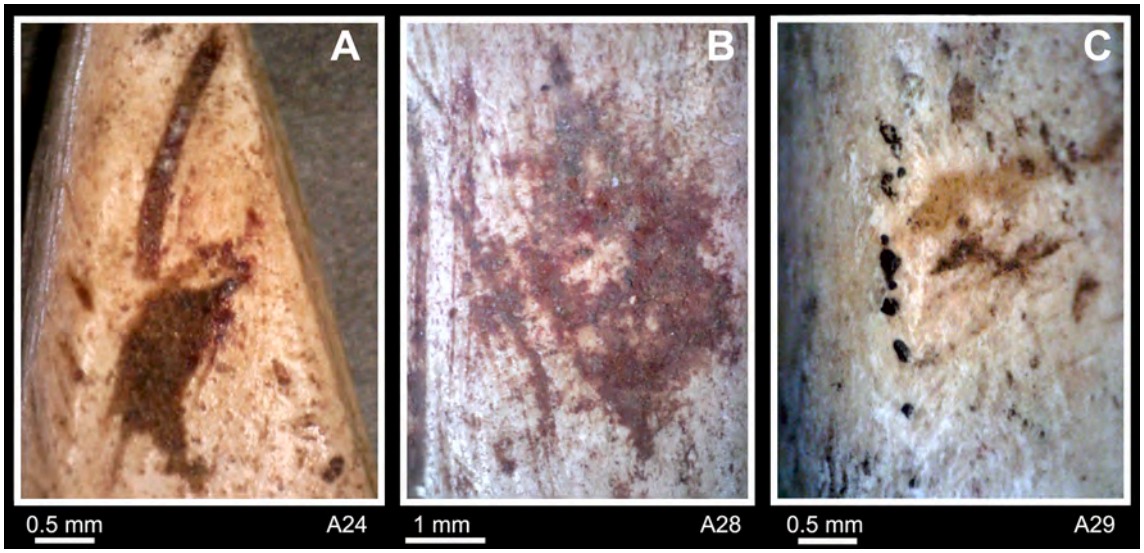

Fig. 6. Detail of pigments on turkey (*Meleagris gallopavo*) bone artifacts A24 (A), A28 (B), and A29 (C) from Feature 94/Burial 24 at the Fernvale site, Tennessee. (A). Pigments are adhered to the surface of the medullary cavity of Artifact A24, and appear within gouges and surface depressions 2.57–6.70 mm from the tool tip. (B) Pigment cluster located 10.75–16.17 mm from the tip of Artifact A28. (C) Surface pigments on the shaft of Artifact A29, located 13.13–16.33 mm from the tool tip.

include reddish brown granular material, as well as dark brown and dark red residues that lack discernable structure.

Minute black residues <0.001 m^2 and without discernible structure are present as surface deposits on tarsometatarsus A25, extending up to 2.5 mm from the tool tip (see Fig. 5B). Small deposits of red residues <0.09 mm^2 and lacking visible structure are also present within the surface topography of tarsometatarsus A25, located approximately 1.19 and 5.24 mm from the tool tip. Finally, both artifacts A24 and A25 exhibit additional trace amounts of reddish residues embedded in low surface areas 1.0–5.5 mm from their tips (see Figs. 5A-B and S3).

Pigment residues on radius A28 consist predominantly of red, brown, and sporadic white crystalline materials adhered to the surface of the artifact and deposited within gouges (Figs. 6B and S2). The largest patch of these residues covers an area of approximately 7.98 mm^2. Red residues lacking discernible structure are present surrounding the crystalline material, appear separately within surface pitting and striations along the tool shaft, and are also worked into polish on the obliquely-cut face of the artifact. Light gray to black pigment remains on radius A29 consist of a line of black surface deposits, each measuring <0.03 mm^2 and extending for 3.18 mm along the tool shaft (Fig. 6C). These residues are located approximately 13.13–16.33 mm from the cut tool tip and lack discernable structure.

Residues that appear on the proximal 19.62 mm of tarsometatarsus A26 are visually-identical in structure and color to those on Radius A28

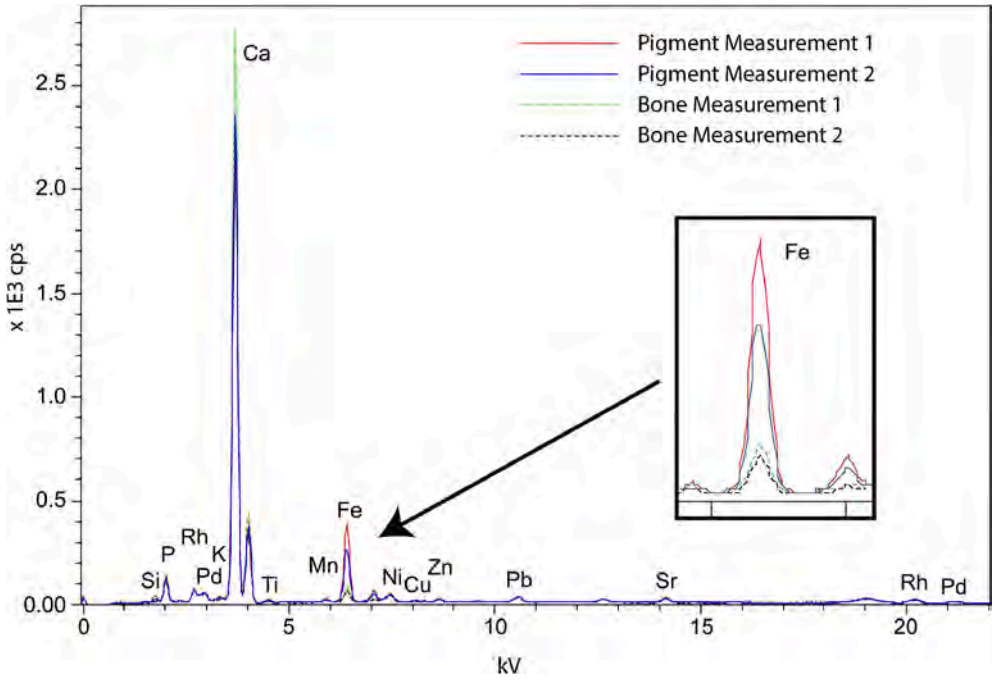

Fig. 7. Spectra generated for two measurements taken on the pigment and two measurements taken on the bone for radius A28 from Feature 94/Burial 24 at the Fernvale site, Tennessee. Detail shows peaks in iron detected during pXRF analysis. Iron Kα peaks recorded for macroscopically visible pigment deposits measured 84,333 NPA and 59,041 NPA. Measurements from elsewhere on the tool shaft where no pigment was visible exhibited iron Kα peaks of 13,152 NPA and 16,385 NPA.

(Fig. S2). Pigment appears as granular surface deposits, as well as along flat surfaces where it is worked into the polish. Elsewhere the pigment is recessed within natural surface pitting and depressions, within the exposed interior structure of the proximal epiphysis, and embedded within parallel cut marks resulting from the manufacturing process.

4.3. pXRF analysis

The pigment remains on tarsometatarsus A24 and radius A28 were examined with pXRF to better understand the composition of the pigment material. For radius A28, two measurements were taken on patches of visible pigment and compared against two measurements collected elsewhere on the tool shaft where no pigment was visible. Net peak areas (NPA) were generated using Artax software as a semi-quantitative means of comparing iron peaks between samples (Forster et al., 2011; Mitchell et al., 2012). The spectra generated by these four measurements clearly indicate elevated levels of iron (Fig. 7). The two measurements for the iron Kα peaks on the pigments measured 84,333 NPA and 59,041 NPA, whereas the measurements taken where there was no pigment exhibited iron Kα peaks of 13,152 NPA and 16,385 NPA. While the pXRF data cannot definitively identify the entirety of pigment composition, the data generated are consistent with iron oxide-derived earth pigments typically referred to in the archaeological literature as ochre.

The largest concentration of visible residues on artifact A24 is located on the medullary surface of the bone (Fig. S3). Natural curvature of this surface prevented contact between the pigment and pXRF receiver during analysis. Consequently, pXRF examination of pigment on artifact A24 did not return usable data.

5. Discussion

Based on the *in situ* arrangement of the artifact cluster from Burial 24 at the Fernvale site, Deter-Wolf and Peres previously suggested that these objects were interred as part of a multi-part cache or bundle (Deter-Wolf and Peres, 2019), which contained up to four groups of artifacts held within discrete biodegradable wrappings (see Fig. 2). Those separate packages were ultimately bound together within an outer covering consisting of a canid (wolf, dog, or coyote) skin with attached paws, as evidenced by partially-articulated phalanges situated along the southern edge of the artifact cluster.

Prior assessment of the Burial 24 materials noted remnants of red earth pigments within the cups of several bivalve shells, and both red and black macroscopically-visible color residues on turkey bone artifacts (Deter-Wolf, 2013b). This contextual evidence links the materials in the artifact cluster to the preparation, storage, and/or application of pigments. Due to this association, Deter-Wolf and Peres (2019) suggested the sharpened turkey tarsometatarsii from the same artifact cluster may have been related to tattooing.

The present study employed direct physical examinations, including assessment of use-wear patterns and pXRF analysis, to test the contextual identification of a possible tattooing function for bone tools from Feature 94/Burial 24 at the Fernvale site. Turkey tarsometatarsii A24 and A25 were found to exhibit distinctive microwear patterns limited to the final 3.26 mm of the artifact tips. The character and extent of microwear signatures on these tools is consistent with those generated during experimental bone tool tattooing (Gates St-Pierre, 2018). These patterns stand in contrast to wear created when bone implements are used for working dry hides, particularly in the absence of spalling or pitting on the tool tips (Buc, 2011; d'Errico and Backwell, 2009). The limited extent of tip polish and absence of oblique striations further attest that the Fernvale artifacts were not used for hideworking activities typically associated with the "awl" typology.

The proximity of pigment remains to the tips of tools A24 and A25 indicates those residues are directly associated with the tattooing process. While we were not able to determine specific elemental composition of residues on tarsometatarsus A24, visual examinations show that these deposits include the same granular, iron oxide-derived ochre pigment assessed on artifact A28 during pXRF analysis. The distribution of larger pigment concentrations 2.57–6.70 mm from the tip of A24, as compared to minute deposits closer to the tips of both artifacts A24 and A25, is consistent with patterns noted in recent experimental studies of bone tool tattooing. Gates St-Pierre's efforts demonstrated that friction generated by passing through skin during tattooing causes most pigment to be pushed several mm up the tool, leaving only trace amounts closer to the tip (Gates St-Pierre, 2018).

Although artifact A26 is missing its tip, the direct association of that tool with tarsometatarsii A24 and A25 suggests it originally served a similar function. Unlike the other two tools, tarsometatarsus A26 exhibits red pigment staining as surface deposits and worked into the polish on its proximal end. This differential staining may indicate artifact A26 was handled, manipulated, or decorated in a different manner than the other tarsometatarsii.

Artifact A27 is incomplete, and the condition of its tip prevents use-wear analysis. Based on its rough surface, manufacturing marks, and separate location within the artifact cluster, artifact A27 is likely either unfinished, or was intended for a separate function than tarsometatarsii A24–A26.

The nature of polish and distribution of residues on artifacts A28 and A29 suggests these cut turkey radii served as implements for mixing and applying pigments. Residual ochre noted by excavators within the cups of associated bivalve shells suggests those objects may have acted alongside radii A28 and A29 during pigment preparation and application. A similar combination of bivalve shells and bone, wood, or feather applicators for holding, mixing, and applying tattooing pigments occurs in Native American bundles from the Great Plains during the early twentieth century CE (Deter-Wolf and Peres, 2019; Krutak, 2013). Whether the pigments on artifacts A28 and A29 are indeed identical to those on the associated tarsometatarsii unfortunately remains ambiguous without more detailed elemental assessments.

Black pigments present on artifacts A25 and A29 were not directly examined during the present effort, but likely derive from carbon. Comparative historical data and direct examinations of tattooed archaeological human remains demonstrate that carbon-based tattoo pigment has been widely-prevalent in societies across the globe for millennia (e.g., Deter-Wolf, 2013a; Friedman, 2017; Krutak, 2007, 2014; Pabst et al., 2009, 2010). Historical Native American tattooing traditions in Canada and the southwestern United States employed both black and red mineral pigments (Gifford, 1940; Opler, 1941; Raudot, 1904 [1709]; Ray, 1942; Spier, 1933; Steward, 1943; Stewart, 1942). Red pigments directly associated with tattooing rituals and regalia also appear in early twentieth century Native American tattooing kits from the Great Plains (Deter-Wolf and Peres, 2019; Foster, 1994; Skinner, 1926). Finally, Iroquoian tattooing implements from the Droulers-Tsiionhiakwatha site exhibit trace amounts of red material visually identified as possible blood residues mixed with ochre (Gates St-Pierre, 2018). Artifacts A24 and A28 from Fernvale both show deposits of granular ochre alongside red residues that lack visible structure under the conditions of the current study, but are visually-similar to those documented on the Iroquoian artifacts.

The composition and arrangement of artifacts from Fernvale Burial 24 is unique at the site. Formal bone tools are relatively rare in the overall site assemblage, which includes just 16 sharpened bone implements in addition to those discussed herein. Only two of those additional artifacts were fashioned from turkey remains, with most of the remainder identifiable as mammal or specifically white-tailed deer (*Odocoileus virginianus*) (Peres et al., 2013). None of the other sharpened bone artifacts from the Fernvale site were associated with groupings of lithics, other zooarchaeological materials, or pigment remains.

A review of published studies, technical reports, and primary site excavation data from central Tennessee reveals that artifact associations like those from Fernvale Burial 24 are unusual within the region. Our

research identified just three reported examples from similarly-dated contexts that include finely-pointed bone implements alongside lithics and/or other zooachaeological artifacts. Most of those items have been reburied according to Tennessee's cemetery laws (Moore, 1989), and none have been specifically examined for use-wear signatures.

Approximately 13 km northeast of Fernvale along the Harpeth River at the Ensworth School site, the Middle- to Late Archaic burial of a probable male aged 18–22 years (Burial 37) included four turkey tarsometatarsii sharpened at their distal ends, along with a single obliquely-cut turkey radius (Deter-Wolf et al., 2004). Those artifacts were positioned near the individual's waist alongside two complete bifacial spear or knife points, a polished beaver (*Castor canadensis*) incisor, and a white-tailed deer antler tine and metacarpal handle. The turkey tarsometatarsii were placed alongside one another with their tips aligned, suggesting they, along with the beaver incisor, were originally contained within a discrete biodegradable wrapping. All remaining materials were distributed across an approximately 70 × 50 cm area south of the tarsometatarsii, and the original location of those artifacts may have been disturbed by an intrusive pit feature. The sharpened tarsometatarsii and obliquely-cut turkey radius from Ensworth Burial 37 are excellent comparative matches to the artifacts from Fernvale Burial 24 described herein, although no pigment residues were present in the Ensworth grouping.

At the Hermitage Springs site, located on the Cumberland River 45 km northeast of Fernvale, a loosely-flexed, likely Late Archaic burial of a pregnant adult female (Burial 263a) included four sharpened turkey tarsometatarsii exhibiting black staining on their tips (Deter-Wolf, 2013a). Those artifacts were aligned with one another, suggesting that they were held within a biodegradable bundle or wrapping. Other objects associated with the burial included a lithic biface, human cranial gorget, bivalve shell, turtle shell, and other faunal remains. There is no report on the Hermitage Springs excavations, and details as to the specific chronological origin and overall arrangement of artifacts in Burial 263a are not known.

Finally, more than 100 km east of Fernvale on the Cumberland River at the Robinson site, the seated burial of a female in her early twenties dated to the first millennium BCE included a collection of 31 artifacts originally arranged within multiple biodegradable wrappings (Morse, 1967; Morse and Peres, 2019). Artifacts from Burial 58 included six split white-tailed deer bone awls, eight bifacial knives or spearpoints, multiple shale and marine shell gorgets, two deer antler tines and an antler handle, and both bobcat and woodchuck mandibles (*Lynx rufus* and *Marmota monax*), as well as other lithic and faunal materials. Fragmentary red ochre remains were also present within the artifact grouping.

6. Conclusions

The practice of tattooing was an essential aspect of Indigenous cultural expression in eastern North America that by the nineteenth century CE had been largely suppressed by Colonial and Euroamerican acculturative forces (Balvay, 2008; Deter-Wolf and Diaz-Granados, 2013; Krutak, 2013, 2014). Decorated human or human-like bodies in the art historical record suggest that vibrant Native American tattooing or body marking traditions existed in the Eastern Woodlands and adjacent regions as early as the eleventh century CE (Cherry, 2009; Diaz-Granados, 2004; Duncan, 2013; Dye, 2013; Reilly, 2013; Walker, 2004), possibly extending back to the first century CE (Steere, 2013; Swartz, 2001). More broadly, recent analysis of a cactus spine tool from southern Utah establishes that tattooing took place in the American Southwest by the second century CE (Gillreath-Brown et al., 2019), while figural art from the American Arctic demonstrates tattooing in the Western Hemisphere by approximately 1700 BCE (Helmer, 1986; Krutak, 2007). Finally, preserved human remains from South America show the practice existed in that region by approximately 2280 BCE (Arriaza, 1988; Deter-Wolf et al., 2016). Despite this evidence, direct identifications of tattooing implements in archaeological collections from the Americas are exceedingly rare, and the full temporal extent of Native American tattooing is not known.

Through traditional zooarchaeological analysis combined with use-wear examinations and materials science studies, we are able to provide a new interpretation of a collection of bone artifacts from an archaeological site in central Tennessee. Our analyses demonstrates that ca. 3500–1600 BCE, Native American inhabitants of the Fernvale site practiced tattooing using single point, sharpened turkey bone tools associated with both red and black pigments. These materials comprise the earliest directly-identified material culture associated with Native American tattooing practices to date.

These findings present the first direct evidence for Archaic period tattooing in the eastern United States, and therefore the specific ways in which these tools and the practice of tattooing connected to the lived experience of the Fernvale community remain unclear. By the Historic period the cultural importance of Native American tattooing in North America's Eastern Woodlands and Great Plains was multivalent (e.g., Deter-Wolf and Diaz-Granados, 2013; Krutak, 2014). The tattooed symbols, eligibility of recipients, identity of the tattooist, actions and performances accompanying the application of the marks, and the tools used in the process all aided in the formation and expression of personal and group identity. Tattoos and the tattooing process marked adulthood, commemorated personal and family history, signaled social status, facilitated the capture of divine energies, and connected individuals to both their communities and to the spiritual world (Duncan, 2013; Dye, 2013; Krutak, 2013, 2014).

By the early twentieth century, the material culture of Native American tattooing in the Eastern Woodlands and Great Plains encompassed not just the tools used to insert pigment into skin, but also an associated suite of objects. Like the materials from Fernvale Burial 24, historic tattooing kits included marking tools, pigments, and layered wrappings (Deter-Wolf and Peres, 2019). On the eastern Great Plains these objects, along with associated regalia and plant medicines, were stored within specific classes of sacred bundles (Deter-Wolf and Peres, 2019; Krutak, 2013). Those portable shrines connected to both the physical and cosmic landscape, manifested and maintained shared heritage and group identity, and were tied to the spiritual well-being of individuals, clans, and entire tribes (e.g. Hanson, 1980; Pauketat, 2012; Zedeño, 2008).

Our findings regarding the function of turkey bone tattooing tools from Feature 94/Burial 24 at Fernvale do not suggest that all sharpened turkey bone "awls" from Archaic sites in the American Southeast, or even all such tools from the Fernvale site, were used to tattoo. Neither does the context of the Fernvale artifacts, situated within multi-layer biodegradable wrappings alongside pigment remains and other zooarchaeological and lithic materials, conclusively demonstrate that these objects were imbued with significance equivalent to historical bundle traditions. Instead this study underscores issues in using broad morpho-functional classification systems to interpret osseous tools, while revealing how these shortfalls may be overcome through specific and rigorous assessment. Combined with future use-wear examinations, elemental assessments, and contextual analysis of other artifact collections, the evidence from the Fernvale site provides a significant data point for examinations of social organization and ritual complexity among Archaic period forager societies of the southeastern United States.

CRediT authorship contribution statement

Aaron Deter-Wolf: Conceptualization, Formal analysis, Investigation, Methodology, Project administration, Resources, Writing - original draft, Writing - review & editing. **Tanya M. Peres:** Formal analysis, Investigation, Methodology, Resources, Writing - original draft, Writing - review & editing. **Steven Karacic:** Formal analysis, Investigation, Methodology, Resources, Writing - original draft.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

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Supplementary Materials for

Ancient Native American bone tattooing tools and pigments: Evidence from central Tennessee

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Text S1. Additional Archaeological Context and Background

The Fernvale site (40WM51) was excavated in 1985 by the Tennessee Division of Archaeology (TDOA) as an archaeological mitigation project associated with a road and bridge replacement project in Williamson County, Tennessee (Deter-Wolf, 2013). That effort ultimately excavated 127 pit features within the planned construction footprint, 27 of which included ancient Native American burials. All graves within the construction footprint were exhumed according to state cemetery statutes (Moore, 1989). Following excavation, the unanalyzed site assemblage was registered under TDOA accession numbers 85-123 through 85-126 and placed in long-term storage in the TDOA's curatorial facility at Pinson Mounds State Archaeological Park in Jackson, Tennessee.

Formal analysis of the Fernvale site assemblage began in 2007 as a collaborative effort between the TDOA and the Department of Sociology and Anthropology at Middle Tennessee State University (MTSU). Those efforts took place under the overall direction of the first author. Peres, then at MTSU, oversaw analysis of all zooarchaeological materials from the site. The technical report on the site was published in 2013 (Deter-Wolf, 2013).

The analyses described herein were conducted between 2007 and 2017. No permits were required for these studies, which complied with all relevant state and federal regulations and proceeded with permission of the Tennessee State Archaeologist. In July, 2018 the Chickasaw Nation submitted a formal repatriation claim for all human remains and associated funerary objects from the Fernvale site under the Native American Graves Repatriation Act (NAGPRA). No analysis or documentation of artifacts described in this paper was conducted following that claim. All skeletal remains and funerary objects from the Fernvale site were repatriated to the Chickasaw Nation in August, 2019.

Fernvale Feature 94/Burial 24

Feature 94 at the Fernvale site was a roughly circular pit situated in the central portion of the excavated site area (Steere and Deter-Wolf, 2013). The feature was exposed at the base of the plow zone following mechanical stripping of disturbed soils, and excavated by hand on May 13, 1985. The pit exhibited inwardly-sloped walls and a rounded base, and extended a maximum of 30 cm below the Ap soil horizon into archaeologically-sterile B horizon subsoil.

Artifacts recovered from the general matrix of Feature 94 using 1/4-inch mesh screen included lithic debitage (n=1,854), 10 finished and two unfinished bifacial points/knives, and quantities of shale (3 g), fire-cracked rock (21 g), and burned limestone (4,344 g)(Tune and Deter-Wolf, 2013). Faunal remains present in the feature fill (n=279) included burned and unburned examples of small- to indeterminate mammal (Mammalia), turtle (Testudines) carapace elements, two snake (Serpentes) vertebrae, three bony fish (Osteichthyes) cranial fragments, and additional untyped vertebrate and mammal fragments (Peres et al., 2013). These materials all present incidental inclusions within the feature matrix and are not directly associated with Burial 24.

Burial 24 was positioned approximately 10 cm above the base of Feature 94, with greater than 75 percent of the skeletal remains present (Hodge and Davis, 2013). This individual was identified as an adult probable male interred in a flexed position on their right side, with head oriented north and arms pulled tight to the chest. Sex was determined based on cranial and postcranial dimorphic traits, including the narrow greater sciatic notch and small, shallow preauricular sulcus; large mastoid processes; broad, blunt supraorbital margin; remnant of the metopic suture; prominence of glabella; large mental eminence; and ruggedness of the nuchal crest. Age was estimated as middle to older adult, with an approximate range of 25 to 55 years

based on the morphology of the pubic symphyses and appearance of the auricular surface. This individual exhibited mild to severe arthritis and mild osteophytosis of the spine, as well as marked dental attrition and antemortem tooth loss. Stature was estimated at 165.79 ± 2.35 mm.

The grouping of artifacts directly associated with Burial 24 and containing the materials examined in this paper was situated in the northeast quadrant of Feature 94 (Table S1). Lithic materials present in the 23 x 25 cm artifact cluster included two bifacial stemmed spear points or knives (artifacts A1 and A2), a bifacial ovate knife (A3), an oblong secondary stage biface (A4), and a wing-tipped drill (A5), all manufactured from locally-available Fort Payne chert. The spear points and drill all exhibit straight to expanded stems with straight to slightly excurvate, unground bases (Tune and Deter-Wolf, 2013). With the exception of the drill, all lithics from this grouping display tan to black hardened, globular residues bonded to portions of their lower (*in situ*) surfaces.

Invertebrate remains within the Burial 24 assemblage include disarticulated single valves of freshwater bivalve shells, grouped into three separate stacks along the northern edge of the artifact cluster. The total number of individual valves originally present in the feature is not known, as only fragmentary remains survived for laboratory analysis. Three fragments were identified as belong to the freshwater mussel family Unionidae, while three are mucket (cf. *Actinonaias* sp.)(A30–A40). Excavation fieldnotes record that degraded red pigment, visually identified as ochre, was present on the interior surface of several shells. Those surfaces are extremely friable, and the pigment residues were apparently lost during initial artifact processing and/or as a result of material degradation prior to comprehensive analysis.

In addition to the turkey bone implements described in this paper, terrestrial fauna within the Feature 94/Burial 24 artifact cluster included a single white-tailed deer (*Odocoileus*

virginianus) antler tine that was scored and snapped distally (A6). The final 17 mm of the rounded tip exhibits low polish, and shows no evidence of notching or wear consistent with use as a pressure flaker or abrader. Also present were 17 dog/wolf/coyote (cf. *Canis* spp.) phalanges, oriented in a partially articulated manner along the southern edge of the artifact cluster (A7–A23). These included four specimens of phalanx #1, two phalanx #2, and 11 phalanx #3 (four of one side and seven of the other). Following excavation the canid phalanges were misidentified as raptor talons, and listed as such in the original site notes and on the initial NAGPRA inventory. That misidentification was corrected during the 2007–2013 analysis effort. Recent assessment suggests that, based on their orientation and stratigraphic position above other materials, the phalanges represent remnants of a canid skin with attached paws that served as a wrapping holding the associated artifacts (Deter-Wolf and Peres, 2019).

Table S1. Artifacts from the Fernvale Feature 94/Burial 24 artifact cluster.

Accession #	Artifact Type	Count	Description
TDOA 85-123-A1 TDOA 85-123-A2 TDOA 85-123-A3	Finished biface	3	Two stemmed spear points/knives (A1, straight stem with rounded base; A2, expanded stem with flat base) and one ovate knife (A3) made from Fort Payne chert. All exhibit tan to black globular residues on bottom (*in situ*) faces.
TDOA 85-123-A4	Secondary biface	1	Thick secondary biface of Fort Payne chert, oval in plan view. Exhibits tan to black globular residue on bottom (*in situ*) face.
TDOA 85-123-A5	Wing-tipped drill	1	Bifacial drill of Fort Payne chert, manufactured from resharpened, stemmed biface.
TDOA 85-123-A6	*Odocoileus virginianus* antler tine	1	Measures 171 mm in length. Scored and snapped distally, tip exhibits polish on distal 17 mm.
TDOA 85-123-A7 through TDOA 85-123-A23	cf. *Canis* spp. Phalange	17	Four specimens are phalanx #1 (A7–A10), two are phalanx #2 (A11–A12), and 11 are phalanx #3 (four right, seven left; A13–A23). All were situated along southern edge of artifact cluster, oriented south and positioned stratigraphically above other artifacts.
TDOA 85-123-A24 TDOA 85-123-A25 TDOA 85-123-A26 TDOA 85-123-A27	*Meleagris gallopavo* tarsometatarsus, left	4	A24–A25 include proximal and shafts, sharpened at distal ends. A26 exhibits partial proximal epiphysis. A27 includes shaft only and is sharpened proximally. Red and black pigments are present on distal tips of A24 and A25. Red pigment is present on proximal epiphysis of A26.
TDOA 85-123-A28 TDOA 85-123-A29	*Meleagris gallopavo* radius, right	2	Both cut at distal end and exhibit polish on cut surface and extending down shaft. Red pigment is present on A28; black pigment on A29.
TDOA 85-123-A30 through TDOA 85-123-A33	Bivalvia	4	One hinge present; stacked cup-up with cf. *Actinonaias* sp. along northern edge of artifact cluster. Field notes record red pigment residues in cups of several shells at the time of excavation.
TDOA 85-123-A34 TDOA 85-123-A35 TDOA 85-123-A36	cf. *Actinonaias* sp.	3	Includes one right valve and one left valve. Stacked cup-up with other bivalves along northern edge of artifact cluster.
TDOA 85-123-A37 TDOA 85-123-A38 TDOA 85-123-A39	Unionidae, left	3	Includes one partial hinge. Situated with other bivalves along northern edge of artifact cluster.
TDOA 85-123-A40	Invertebrata fragments	4	Situated with other bivalves along northern edge of artifact cluster.

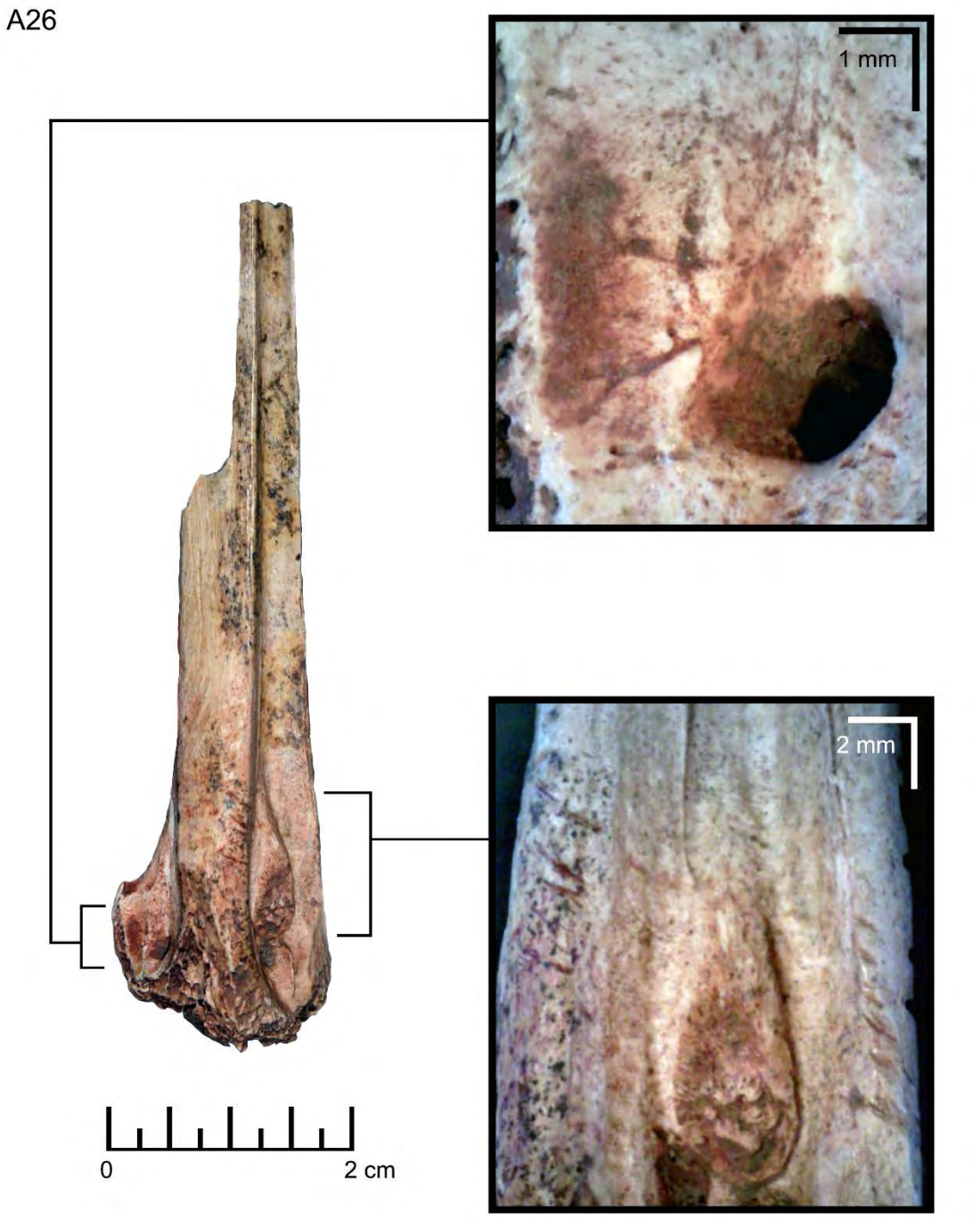

Fig. S1. Detail of residues (top right) and cut marks (bottom right) on tarsometatarsus A26 from Fernvale Feature 94/Burial 24.

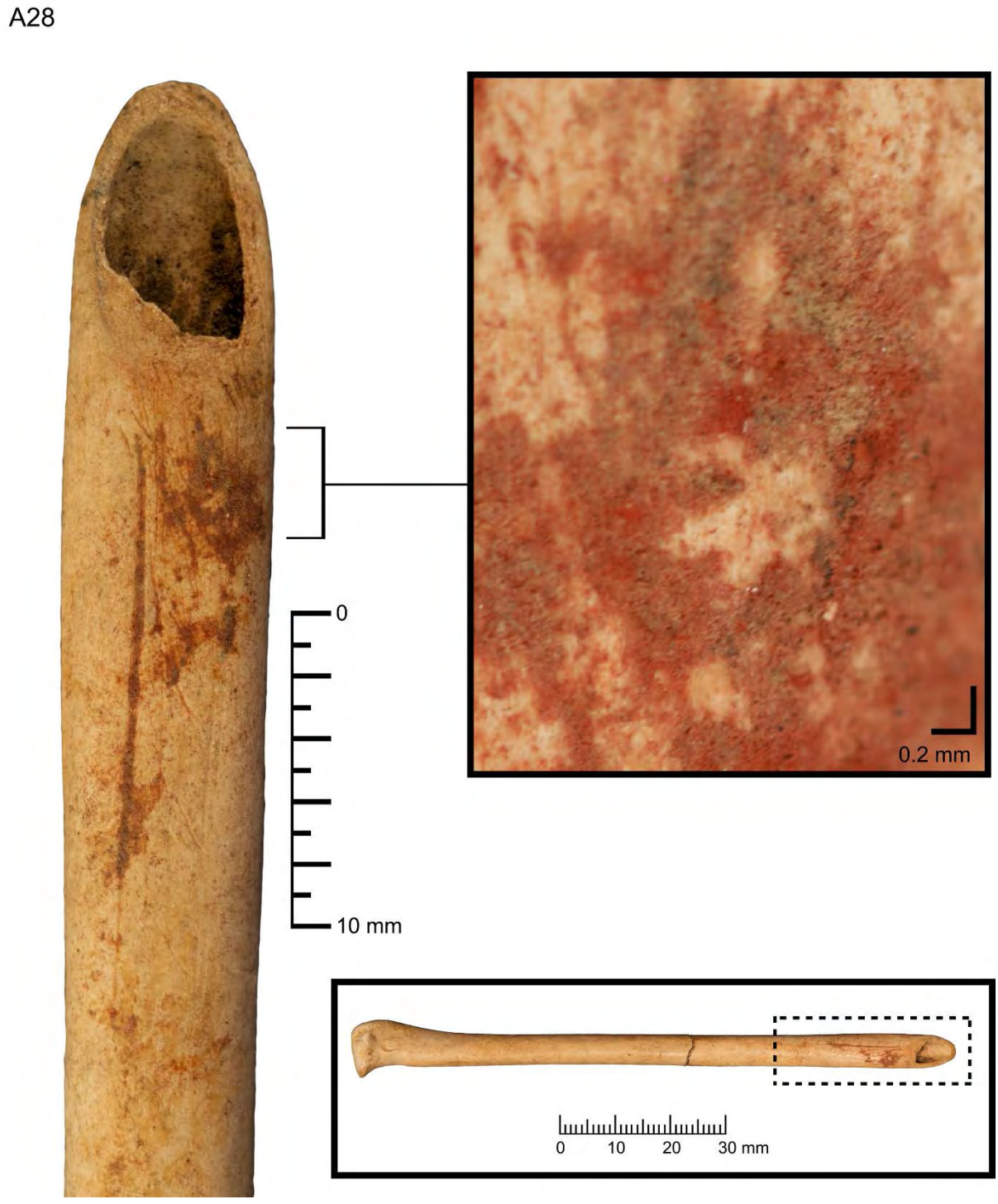

Fig. S2. Detail of residues on radius A28 from Fernvale Feature 94/Burial 24.

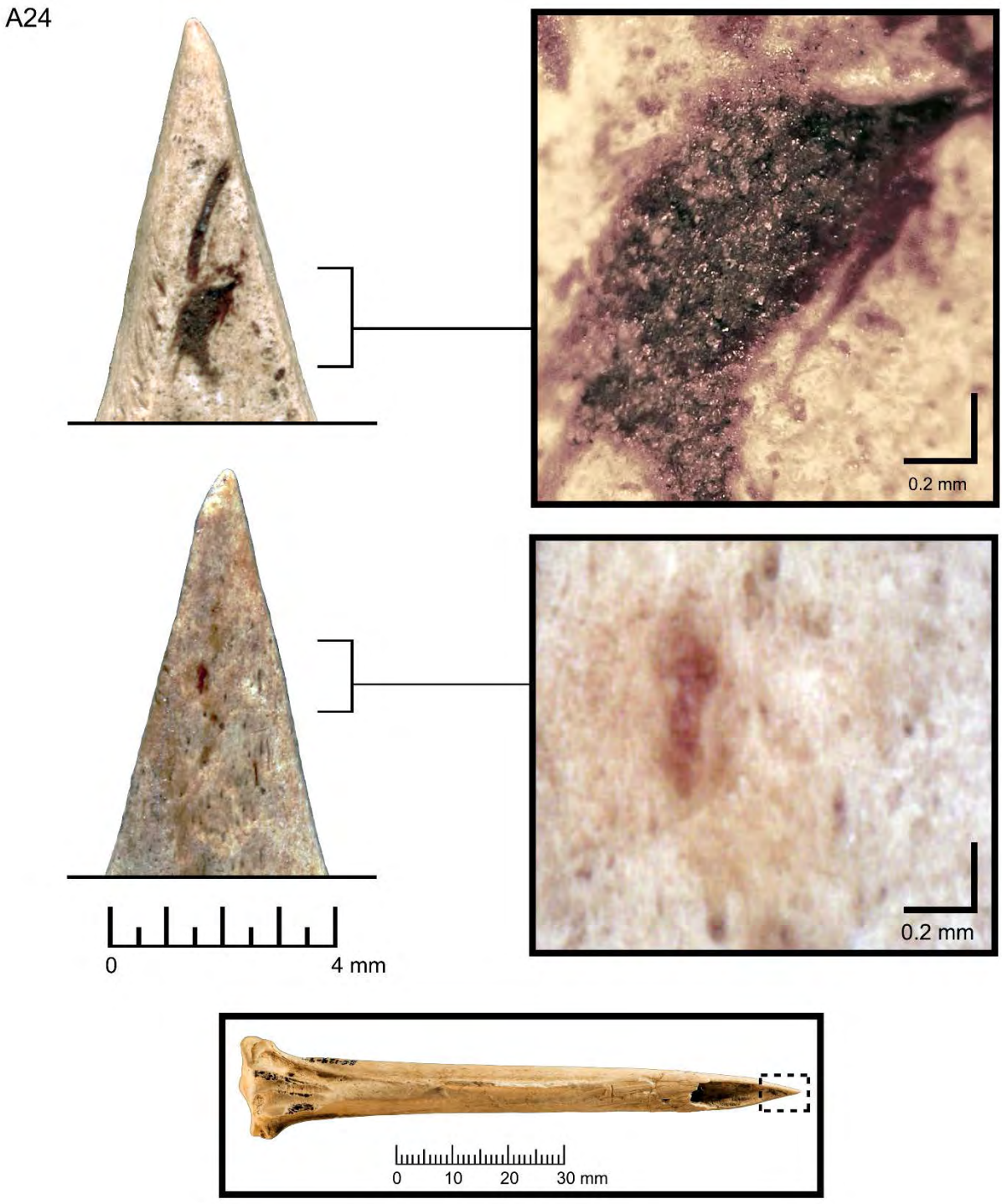

Fig. S3. Detail of residues on tarsometatarsus A24 from Fernvale Feature 94/Burial

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