Institutional Database of Staff Publications
Tennessee Division of Archaeology

Title:	Flint, Bone, and Thorns: Using Ethnohistorical Data, Experimental Archaeology, and Microscopy to Examine Ancient Tattooing in Eastern North America
Year:	2013
Name(s):	Aaron Deter-Wolf and Tanya M. Peres
Source:	*Tattoos and Body Modifications in Antiquity: Proceedings of the Sessions at the Annual Meetings of the European Association of Archaeologist in The Hague and Oslo, 2010/11,* edited by Philippe Della Casa and Constanze Witt, pp. 35-48. Zurich Studies in Archaeology 9. Chronos-Verlag, Zurich.
Publisher Link:	https://www.chronos-verlag.ch/node/20801

Zurich Studies
in Archaeology
Vol. 9_2013

Tattoos and Body Modifications in Antiquity

Proceedings of the sessions at the EAA annual meetings in The Hague and Oslo, 2010/11

edited by
Philippe Della Casa
Constanze Witt

Table of Contents

5 **Aspects of Embodiment – Tattoos and Body Modifications in Antiquity**
Philippe Della Casa & Constanze Witt

9 **Matters of Identity: Body, Dress and Markers in Social Context**
Philippe Della Casa

15 **The Material Culture and Middle Stone Age Origins of Ancient Tattooing**
Aaron Deter-Wolf

27 **The Power to Cure: A Brief History of Therapeutic Tattooing**
Lars Krutak

35 **Flint, Bone, and Thorns: Using Ethnohistorical Data, Experimental Archaeology, and Microscopy to Examine Ancient Tattooing in Eastern North America**
Aaron Deter-Wolf & Tanya M. Peres

49 **Body Modification at Paracas Necropolis, South Coast of Peru, ca. 2000 BP**
Elsa Tomasto Cagigao, Ann Peters, Mellisa Lund & Alberto Ayarza

59 **Interpreting the tattoos on a 700-year-old mummy from South America**
Heather Gill-Frerking, Anna-Maria Begerock & Wilfried Rosendahl

67 **Bronze Age Tattoos: Sympathetic Magic or Decoration?**
Natalia. I. Shishlina, E. V. Belkevich & A. N. Usachuk

75 **One More Culture with Ancient Tattoo Tradition in Southern Siberia: Tattoos on a Mummy from the Oglakhty Burial Ground, 3rd-4th century AD**
Svetlana V. Pankova

89 **Tattoos from Mummies of the Pazyryk Culture**
Karina Iwe

97 **The Tattoo System in the Ancient Iranian World**
Sergey A. Yatsenko

103 **Intentional Cranial Deformation: Bioarchaeological Recognition of Social Identity in Iron Age Sargat Culture**
Svetlana Sharapova

115 **Roman Cosmetics Revisited: Facial Modification and Identity**
Rhiannon Y Orizaga

Philippe Della Casa & Constanze Witt (eds) Tattoos and Body Modifications in Antiquity. Proceedings of the sessions at the EAA annual meetings in The Hague and Oslo, 2010/11. Zurich Studies in Archaeology vol. 9, 2013, 35-45.

Flint, Bone, and Thorns: Using Ethnohistorical Data, Experimental Archaeology, and Microscopy to Examine Ancient Tattooing in Eastern North America

Aaron Deter-Wolf[1] & Tanya M. Peres[2]

[1] Tennessee Division of Archaeology, 1216 Foster Ave, Cole Bldg. #3, Nashville, TN 37243, USA, Aaron.Deterwolf@tn.gov

[2] Department of Sociology and Anthropology, Middle Tennessee State University, MTSU Box 10, Murfreesboro TN 37132-0001, USA, Tanya.Peres@mtsu.edu

This chapter describes ongoing research into the archaeological remains of ancient tattooing in North America's Eastern Woodlands. Ethnohistorical sources are first examined to identify indigenous tattoo technologies and tools. Those tools are then replicated and applied in an experimental test to determine which are best suited to the practice of tattooing. Finally, this research explores the utility of scanning electron microscopy and energy-dispersive X-ray spectroscopy in identifying tattoo implements from archaeological collections. While none of these techniques provide indisputable means of identifying ancient tattoo implements, together they provide a more robust understanding of ancient Native American tattooing practices. Keywords: Tattoo, Use-wear, America, Needle, Woodlands

1. Introduction

The surviving ships of the second Corte-Real expedition returned to Lisbon in October 1501 from their voyage to the North American coast, carrying on board captive Native Americans taken along the eastern seaboard somewhere between modern Delaware and Nova Scotia. Shortly after their arrival, Italian diplomat Alberto Cantino described the captives in a letter home, noting that the faces of the men were "marked with great signs" (Markham 1893, 233-234). The account by Cantino and letters of his fellow Italian Pietro Pasqualigo (Markham 1893, 235, 237) are among the earliest recorded European descriptions of Native American tattooing.

The Corte-Real expedition was part of the initial surge of exploration and settlement that would spread across eastern North America during the ensuing centuries. That process brought Europeans and Euro-Americans into frequent contact and conflict with the indigenous people of the region, and resulted in the creation of a robust ethnohistorical record. Although the specific geographic areas documented in accounts of this period vary widely, one consistent aspect of the ethnohistorical record is descriptions of the tattooed patterns and colours inked on the bodies of Native Americans.

Tattooing was both widespread and well-established throughout eastern North America prior to the sixteenth century, and flourished as a part of various late prehistoric Native American cultures, including the Mississippian, Fort Ancient, and Calusa traditions. Beginning approximately 1000 AD, elaborate motifs and patterns are shown tattooed on the faces and bodies of individuals depicted on rock art panels (Diaz-Granados 2004; Diaz-Granados & Duncan 2000), carved shell artefacts (Holmes 1880), and ceramic effigy vessels (Walker 2004) from throughout the region (Fig. 1). Although the specific antiquity of tattooing in North

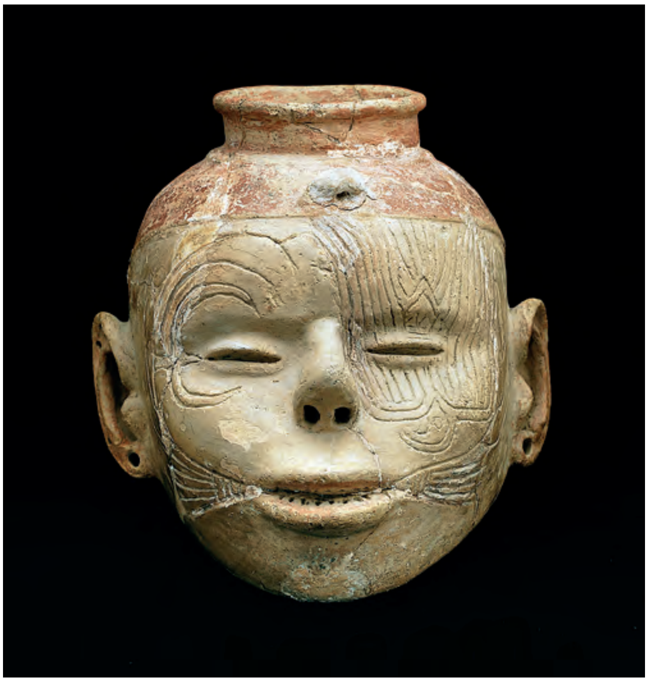

Figure 1. Facial tattooing on a late prehistoric ceramic effigy vessel from Arkansas (photo by David H. Dye).

Figure 2. Map of the study area in eastern North America.

America has not yet been defined, facial designs on figurines and effigy pipe bowls from the Middle Woodland cultures of the Ohio Valley suggest that Native American tattooing dates to at least the third century AD (Giles 2010; Swartz 2001).

Ancient Native American tattooing was deeply-rooted, geographically widespread, and culturally important to its practitioners. However, little effort has been exerted to identify the material remains of the practice, and to date there have been only three formal, published identifications of tattoo implements or paraphernalia from the archaeological record of eastern North America (Knight 2004, 2010; Otto 1975; Painter 1977). The research presented here attempts to shed new light on to the material culture of ancient Native American tattooing. First, ethnohistorical sources from the sixteenth through nineteenth centuries are examined to identify possible Native American tattoo implements. Specific implements are then replicated and tested in a controlled fashion in order to determine which were best suited to the practice of tattooing. Finally, select tools are examined using a scanning electron microscope (SEM) and energy-dispersive X-ray spectroscopy (EDX) in an effort to identify distinctive wear patterns and examine the utility of these instruments in the identification of tattoo needles from the archaeological record.

2. Ethnohistorical Descriptions of Tattoo Needles

The region of study for this investigation consists of the culture area of the North American continent traditionally identified as the Ern Woodlands. This area begins along the Atlantic seaboard and Gulf of Mexico, and is generally bounded to the west by the Mississippi River and to the north by the sub-arctic regions of Canada, although it extends beyond these borders in some areas to encompass regional cultural traditions (Fig. 2). The effort to identify Native American tattoo implements from the Eastern Woodlands relied principally on ethnohistorical sources compiled by Sinclair (1909), Swanton (1987), and Wallace (1993). This data was supplemented by archival research examining additional European and Euro-American accounts from between the sixteenth and nineteenth centuries.

Numerous European chroniclers document the existence of tattooing among Native American populations, but like Cantino and Pasqualigo include little expository information regarding indigenous tattoo tools. For example, John Smith (1907 [1624], 63) records that among the native Virginians, the women "have their legs, hands, breasts and face cunningly embroidered with divers works," but makes no mention of the actual items used to achieve this effect. During a 1564 colonization attempt in Florida, the Frenchman Nicolas Le Challeux wrote that "for ornament they have their skins inlaid (marqueté) in a strange fashion" (Le Challeux 1875 [1579], 461). From that same expedition, René de Laudonnière recorded that most of the Native American men "ornament their bodies, arms, and thighs with handsome designs. The ornamentation is in permanent color because it is pricked into the skin" (Laudonnière 2001 [1586], 9-11).

A number of ethnohistorical sources provide accounts of the tattooing process, but include only broad descriptions of the specific tattoo implements. The naturalist William Bartram (1791, 503) describes Native American tattooing simply as "pricking the skin with a needle." French military officer Jean Bernard Bossu himself received a tattoo while living among the Quapaw in Alabama, and provides one of the most thorough accounts of indigenous tattooing in the region. However, Bossu describes the tools used to mark his skin only in passing:

"An Indian burnt some straw, the ashes of which he diluted with water: he made use of this simple mixture to draw the roe-buck; he then followed the drawing with *great needles*, pricking them deep into the flesh until the blood comes out; this blood mixing with the ashes of the straw, forms a figure which can never be effaced." (Bossu 1771, 107, emphasis added). Similar basic identifications of needles appear elsewhere in Bossu's account (1771, 163, 235), as well as in the writings of Bressani (1899, 250), Dièreville (1933 [1708], nicaut (Margry 1887, 467).

Ethnohistorical accounts such as those identified above describe Native American use of a simple unhafted needle for tattooing. However, the single-needle instrument was not a pan-regional adaptation. In his letters from Eastern Canada, Raudot (1904, 64-65) writes that tattoos were given using "two or three well-sharpened fish or animal bones, which they bind separate from each other to the end of a piece of wood." The compound, in-line tattoo implement which Raudot describes is strikingly similar to implements recorded by Long (1791, 48), James (1905 [1823], 74), and Le Page Du Pratz, who wrote that six needles were hafted "in such a manner that they only stick out about the tenth part of an inch" (Le Page Du Pratz 1947 [1758], 346). Compound tools of this same configuration, but employing European-introduced metal needles, are also identified by the French historian Dumont de Montigny: "five medium-sized sewing needles are taken, which are arranged on a little flat, smooth piece of wood and fastened to the same depth, so that one point does not extend out beyond the others. These needles are then soaked in the color and moved quickly, being applied lightly to the design, which had before been traced on the body, and the color insinuates itself between the skin and the flesh through these needle holes" (Dumont de Montigny 1753, 140).

The passage from Dumont de Montigny describes tattooing in the early eighteenth century following the influx of European trade goods to the Eastern Woodlands. The introduction of metal needles changed indigenous tattoo practices throughout North America, and resulted in the abandonment of pre-European materials. Although from well outside the study area, Mallery's 1886 account of tattooing among the tribes of North America's Pacific Northwest provides an excellent explanation for the shift from native technology to metal needles. Prior to European contact, Mallery wrote, Native Americans used bone, thorns, and the dorsal spines of fish to perform tattooing, "though at present needles are employed, as they are more effective and less painful, and are readily procured by purchase" (Mallery 1886, 49). Because of the present focus on prehistoric material culture of the region, references to the use of post-contact metal needles are not further considered in this discussion.

Many ethnohistorical descriptions of indigenous Native American tattoo implements are non-specific, and while they may identify the use of needles, often do not include the material type from which those tools were manufactured. Nevertheless, the ethnohistorical record allows for the identification of three broad categories of tattoo implements employed in the study area prior to the introduction of European metal needles. These categories consist of faunal remains, botanical materials, and stone tools.

Most chroniclers who identify the general material type of indigenous tattoo implements report the use of faunal materials. Lafitau (1977 [1724], 33) describes "needles or little bones" used to tattoo by the Iroquois in eastern Canada. An anonymous early-eighteenth century account from among the Natchez documents the use of "a needle or a little bone well sharpened" (Swanton 1987, 535). Other sources including Mallery (1886, 49; 1893, 395) and Marest (1931, 124) also identify the use of faunal material consisting of small, sharpened bones.

In eastern Canada, the Frenchmen Sagard (1866, 347) and Raudot (1904 [1725], 64-65) identify the use of fish, animal, and bird bones for tattooing. Recent archaeological identification of sharpened fish spines from the site of Moundville, Alabama (Knight 2004; 2010) as possible tattoo implements fits well with these accounts. Moravian missionary Johann Heckewelder (1876 [1818], 206) identifies the use of fish teeth as tattoo needles among the Tuscarora, while both Adair (2005 [1775], 384) and Gatschet (1882, 15) specify the use of gar dentition by the Chickasaw and Chitimacha. In addition to the family Lepisosteidae (including the longnose, alligator, spotted, and florida gar), there are few other fish from the study area with dentition sizable enough for use as tattoo implements (Fig. 3). Gar, bowfin (Amia calva) and members of the family Esocidae (northern pike and muskellunge) were present throughout much of the Eastern Woodlands prior to the twentieth century, and appear in both ritual and domestic archaeological contexts (e.g., Jackson & Scott 2003; Lewis & Kneberg 1946; MacCord 1953).

The claws and teeth of diverse animal species exploited by the prehistoric inhabitants of the region also provide possible examples of tattoo implements. Fangs and teeth of snakes were used historically for scarification and scratching rituals (Wallace 1993), and while they are not explicitly identified in the ethnohistorical record, could also have been used to tattoo. The canines and claws of various terrestrial species including wolf, large cat, beaver, badger, and bear may also have served this function. The bones of all these animals appear periodically in both midden and mortuary contexts at prehistoric sites throughout the region (e.g., Fox & Molto 1994; Jackson & Scott 2003; Lewis & Kneberg 1946; Mills 1902; Peres 2010).

Botanical materials are not well-represented in ethnohistorical accounts of tattooing compared to faunal remains. According to Sparke, Native Americans along the Florida coast during the sixteenth century used "a thorn to prick their flesh" (Payne 1907, 56). Two accounts from the Jesuit Relations identify the use of thorns alongside other tattoo implements in Eastern Canada. Bressani (1899, 250) writes that the Huron used "needles, sharp awls, or piercing thorns," while Jouvency (1896, 279) describes tattooing with "awls, spear-points, or thorns." There are a number of thorny

Figure 3. Alligator gar mandible with partially intact dentition.

Figure 4. Selected tools prepared for experimental testing:
a-c deer metatarsal awls
d turkey metapodial awl
e catfish dorsal spine
f alligator gar teeth
g bobcat claw
h sharpened river cane
i honey locust spine
j lithic flake
k flint graver
l bifacially flaked point

species native to the Eastern Woodlands that may have provided the tools for indigenous tattooing. These include the honey locust and other members of the genus Gleditsia, osage orange (Maclura pomifera), black locust (Robinia pseudoacacia), Washington hawthorn (Crataegus phaenopyrum), and native buckthorns (Rhamnus spp.).

Another botanical material that may have been used for tattooing is sharpened river cane (Arundinaria gigantean). One source from outside the region cites the use of split or sharpened reeds to tattoo (Major 1870), while both Adair (2005 [1775]) and Lawson (1937 [1709]) record that sharpened cane was used for ritual scratching and cutting in the Eastern Woodlands. Sharpened cane slivers could easily be the tools which European chroniclers simply described as "needles" in the ethnohistorical record.

Any of the botanical materials described above would have been readily available to prehistoric inhabitants of the region. However, all of these items are biodegradable and rarely preserve intact in the archaeological record. Instead, their presence in the prehistoric artefact assemblage is typically limited to the recovery of burned or fragmentary materials from feature and midden contexts.

Other than the "spear-points" recorded by Jouvency (1896, 279), there exist only two additional ethnohistorical accounts from the Eastern Woodlands of lithic tools being used to tattoo. Long (1791, 48) records that during his own tattooing by the Ojibwa, thicker lines were incised using a gun flint. Finally, Heckewelder (1876 [1818], 206) identifies the use of "sharp flint stones" among the Tuscarora.

Prehistoric sites in the Eastern Woodlands have yielded large quantities of chipped stone implements and lithic debitage. The "spear points" recorded by Jouvency (1896, 279) lmost certainly consist of bifacially flaked projectile points or knives. Other formal stone tools such as flint gravers may also have functioned as tattoo implements (Painter 1977). The distal ends and broken edges of prehistoric lithic debitage also provide numerous potential tattoo tools.

3. Experimental Tattooing

Any of the faunal, botanical, or lithic objects described above is capable of piercing human skin, and therefore may plausibly have functioned as tattoo tools. However, these items exhibit varying degrees of relative sharpness and ease of manipulation that could impact their actual utility as tattoo needles. Therefore a series of tests were conducted in order to assess the effectiveness of possible ancient tattoo implements from the Eastern Woodlands. These examinations included experimental replication of tool types identified in the ethnohistorical and archaeological record of the region (Fig. 4), and application of those tools to administer tattoos.

Raw materials for experimental analysis were gathered from a variety of sources, including taxidermy shops, Internet vendors, and the natural environment (see Acknowledgements). While some raw materials could be easily procured, several faunal items identified in the ethnohistorical record were impossible to obtain either as a result of limited availability or due to state and/or federal laws regarding species protection, and therefore were not tested (Table. 1).

Table 1. Summary information on implements selected for experimental analysis.

Category	Tool	Description/Notes	Summary Results
Faunal	Turkey metapodial awl	Cut bone awl sharpened using flake tools and abrading	Excellent control and penetration, results in reasonably clean line.
	Deer metatarsal awl	Splintered bone awl sharpened using flake tools and abrading	Good control, excellent penetration, results in reasonably clean line.
	Catfish dorsal spine	Sharpened using flake tool and grinding	Excellent control and penetration, results in reasonably clean line.
	Gar teeth	Longnosed and alligator gar teeth, extracted from jaws using flake tools	Longnosed gar too fragile / Alligator gar teeth barbed at point.
	Mammal claws	Unmodified bobcat claw	Difficult penetration.
Botanical	River cane needle	Sharpened with flake; fire-hardened, green, and brown examples tested	Good control and initial penetration. Tip breaks quickly on all samples.
	Honey locust spine	Fire-hardened and unmodified examples tested	Good control and excellent penetration. Tip breaks after several punctures.
	Osage orange thorn	Fire-hardened and unmodified examples tested	Good control and excellent penetration. Tip breaks after several punctures.
	Small plant thorn	Collected from thorny vine; unmodified	Easily splinters or breaks / eliminated from consideration
Lithic	Bifacially flaked point	Pressure flaked using antler tine	Excellent control and penetration. Flake serrations result in irregular wound.
	Graver spur	Pressure flaked using antler tine	Excellent control and penetration; also highly effective for linear slicing.
	Flake	Large tertiary stage flake with intact distal tip	Distal tip creates linear slices rather than individual punctures. Broken corner is moderately effective.

Experimental replication of possible tattoo implements was performed manually using lithic tools. Deer metapodials were defleshed with a flint blade and split using bipolar lithic percussion. The resulting splinters were then sharpened using flint blades and a progression of increasingly fine-grained quartzite and sandstone abraders. Turkey metatarsal awls were initially cut to shape using flint blades and flake tools, and sharpened using stone abraders. Longnose and alligator gar teeth were removed from the jaws using a flake tool. River cane segments were splintered and sharpened using a combination of flake edges and abrading.

Initial experimental tests were performed with the aid of Nashville, Tennessee, tattoo artist Chris Saint Clark, in order to gain a professional perspective on the relative suitability of the selected tools (Fig. 5). Subsequent tests were performed under archaeological laboratory conditions. The subjects for these tests consisted of sides of adult male pig, including the upper rib cage, meat, and skin, which had been scraped during processing in order to remove hair. These cuts were selected due to their similarity to human skin in regard to texture, pore size, and follicle structure (Swindle 2008).

Prior to tattooing, the area of the pigskin to be tested was rubbed with petroleum jelly to prevent extraneous ink staining. All selected tools were dipped in modern commercial tattoo ink and used to hand-tattoo lines at least 10 cm in length, or until the tool broke. The tools were repeatedly dipped in ink during the tattooing process, and additional pigment was periodically applied to the surface of

Figure 5. View of experimental tattooing using a sharpened river cane needle.

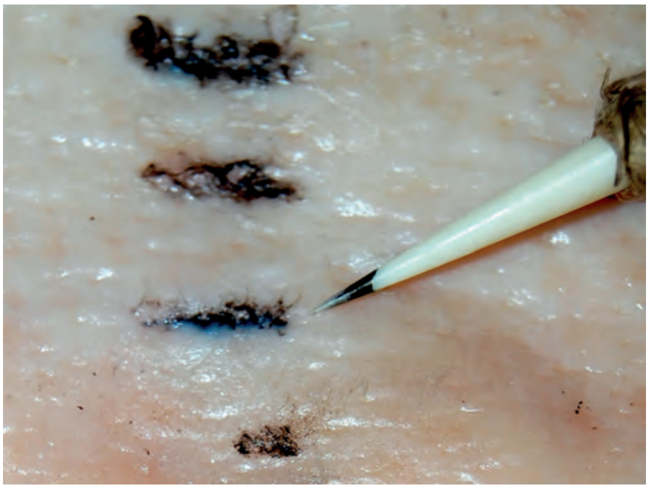

Figure 6. Tip of a deer bone needle and resulting tattooed line.

the subject. Excess ink was subsequently cleaned from the lines using water and paper towels, and the tattoo punctures were examined.

In order to effectively assess the results of this experiment it is necessary to understand the process of tattooing. From a dermatological standpoint, a tattoo disrupts the barrier function of the epidermis and places pigment (ink) within the upper layer of the skin's dermal tissue. A tattoo needle creates a wound that pierces both the epidermal shield and dermal-epidermal junction. Ink is deposited into the upper dermis either on the tip of the needle, or by rubbing pigment into the surface of the open wound. As the skin heals, tattoo ink becomes trapped immediately beneath the dermal/epidermal boundary, forming a permanent colour deposit. Any surface pigment or ink deposited in the epidermal layer gradually flakes away as that outermost layer of skin heals.

The modern electrically powered tattoo machine allows modern tattoo artists to puncture skin up to 3,000 times per minute, resulting in the rapid creation of thickly clustered ink deposits (Atkinson 2003). When viewed from any distance, this dermal pointillism creates the impression of lines and/or solidly tinted areas. To achieve these same effects using nonelectric in-line needle technology requires exponentially more concentration and skill by an artist, who must cluster ink deposits closely enough to form solid lines without repeatedly overlapping earlier punctures and thereby creating a large wound. This traditional style of tattooing is known by modern practitioners as hand picking, and has been described as "painstakingly slow" (Vale & Juno 1989, 133).

From a functional perspective, any object that can puncture the epidermal shield, regardless of its length, size, or relative sharpness, may be used to hand pick a tattoo. However, a successful tattoo implement should allow enough control that a tattooist can breach the epidermal shield but avoid entirely piercing the subject's dermis. If a tool entirely punctures the dermis, ink introduced to the wound will not become encapsulated during the healing process. This failure results in fuzzy or "blown out" lines, ink bleed, and the indistinct images associated with modern non-professional tattoos. Both the epidermis and dermis vary in thickness depending on the location on the body. The epidermis generally ranges between 0.05-0.1 mm in thickness, while the dermis varies between 0.5-5 mm (McGrath & Uitto 2010). For successful ink encapsulation, a potential tattoo implement should therefore be able to consistently pierce skin to a depth of approximately 0.1-0.2 mm. Tattoo implements with blunted or wide tips are very difficult to force through the epidermal shield while maintaining any measure of control over the depth of the puncture.

In addition to resulting in indistinct lines, a wound that entirely pierces the dermis and underlying tissue may also result in severe pain, scarring, and infection. The importance of enduring high levels of pain during rites of passage has been well documented among Native American groups in other contexts (e.g., Dorsey 1903). However, both scaring and infection of a tattoo wound are likely to result in corruption of the visual image, an outcome that is antithetical to the fundamental intent of a tattoo. The sharpness of a tattoo implement therefore has a direct impact on not only the pain endured by the subject, but also on the overall quality and legibility of the tattooed design.

With these factors in mind, several criteria were employed in determining the success or failure of each tool examined during the experimental tattooing process. The first criterion for successful tattoo implements was that they be easy to control regarding the angle and depth of the puncture. As described above, these factors have a direct impact on both the quality of the finished tattoo and the pain suffered by the recipient.

The second criterion was the sharpness of the implement. In order to create the final appearance of a solid line or shaded area, a tattoo tool must be able to create small, discrete wounds grouped very closely. If the tip of an implement is too large or jagged, separate punctures will run together and create a linear tear in the flesh. Such a wound results in increased pain on the part of the recipient, greater risk of infection, additional time required to heal, and a reduction in the quality of the final image.

The final qualification was that the implement survive the testing process unbroken, and potentially continue to function for the sustained period of time necessary to create multiple lines or an entire pattern. Any implement that breaks during tattooing will both compromise the quality of the line and present health risks to the subject should any fragments of the tool remain within the wound.

Bone awls fashioned from splintered deer and turkey metatarsals, and sharpened catfish spines provided good control and excellent penetration (see Fig. 4a-d; Fig. 6). Those tools with the most finely pointed tips resulted in the creation of clean lines of discrete punctures, and were deemed completely satisfactory as tattooing implements. Tools with larger gauge tips were somewhat less effective, requiring more force to penetrate the skin and resulting in wider, less controlled wounds.

Experimental testing was attempted using both longnose and alligator gar teeth. Unfortunately, while longnose gar teeth are extremely sharp, the dentition of the obtained

Figure 7. Tips of dry (left) and fresh (right) river cane needles showing breakage resulting from use.

specimen proved too fragile to survive processing and extraction efforts. It is possible that teeth from larger animals, such as were present in the region during the prehistoric and early contact period, would have survived processing and been successfully tested.

The small, conical external teeth of an alligator gar are needle-like in appearance, but like those of the longnose gar could not be extracted in an intact fashion suitable for testing. Although the large interior laniary teeth of an alligator gar were successfully extracted from the jaw, they proved unsuited to successful tattooing. These teeth feature barbed heads (see Fig. 3, Fig. 4f), which resisted puncturing the skin of the test subject. The application of pressure necessary to force the barbed head through the epidermal shield typically resulted in abrupt and uncontrolled perforation of the test subject's skin, and breaching of the dermal/epidermal junction. In addition, the tested alligator gar teeth were difficult to manipulate and control, and could not be adequately hafted.

As described above, animal claws are not specifically identified as tattoo implements in the ethnohistorical record. Nevertheless, unmodified bobcat claws (Lynx rufus) were tested during experimental analysis to evaluate their relative successfulness (see Fig. 4g). This species was selected over other mammals because of its relative claw size (able to be easily held and manipulated) and sharpness. The bobcat claws provided poor skin penetration during the testing process, relative to other tested implements. While they could be forced through the epidermal layer, the necessary application of force resulted in a corresponding loss of depth control. Consequently, these items created deep punctures extending through the dermal layer, and resulting in unsatisfactory ink deposition. The claws of these or other animals might benefit from some modification in the form of sharpening, which would allow for easier and finer penetration. However, sharpened animal claws are relatively rare in the archaeological record of the Eastern Woodlands compared to other deliberately modified faunal remains.

Prior to experimental testing, the river cane, honey locust spines, and osage orange thorns were among the anticipated favourites for likely tattoo implements (see Fig. 4h & i). These items are very sharp, require minimal modification, and were readily available throughout the region. It was initially believed that they could have been the "thorns" described in ethnohistorical accounts. However, experimental tests quickly showed these materials were not well suited for tattooing, as their tips quickly hinged and/or blunted (Fig. 7). The distal tips of both dry and green river cane needles, including one example which was fire-hardened, broke almost immediately. Osage orange and honey locust spines each provided excellent control and penetration for approximately 15 punctures before also breaking. Although these implements could be resharpened, pausing to retool a tattoo implement after so few punctures is highly impractical.

There have been prior academic tests in which lithic flakes were used to tattoo (e.g., Kononenko & Torrence 2009), as well as successful experiments by other professional tattoo artists (e.g., Dale 2012; Reime 2003). During the current examination, all tested lithic materials proved moderately successful as tattoo implements. A bifacially flaked stone

Figure 8. Flint graver and resulting tattooed line.

point provided excellent skin penetration, as well as depth and angle control (see fig. 4l). However, miniature incidental serrations created by flake removal along the edge of the tool resulted in a jagged-edged elliptical wound rather than a circular puncture. In addition, the ovate, triangular tip of the tool resulted in a tendency for closely-grouped punctures to run together into a linear tear. Spacing the perforations widely enough apart to prevent inadvertent overlapping resulted in the creation of individual tattooed dots rather than a unified line of colour.

During the experimental testing both the distal tip and an unmodified corner of a tertiary-stage flake were examined for their effectiveness at creating discrete, closely-grouped punctures (see Fig. 4j). Both these implements easily pierced the epidermis of the test subject and were easy to control in regard to the depth of the wound. The flat profile of the flake tip created a series of small linear marks, while the irregular profile of the flake edge resulted in creation of a series of punctures, which would join into a single tear if grouped too closely.

A second test was conducted in which the margin of the flake was used to create a linear slice through the subject's epidermis. The sharp edge created a very narrow cut through the skin, and allowed for excellent control over the depth of the wound. Pigment rubbed on the top of this incision resulted in creation of a clean, solid line. The process of creating shallow linear incisions and subsequently introducing pigment from the surface is known as "cutting" or "ink rubbing" in the parlance of modern body modification (Vale & Juno 1989). However, ethnohistorical evidence from the study area does not generally support that indigenous tattoos were being administered in this fashion. The single notable exception is the account by Long (1791, 48), who records that portions of his own tattoo were "incised" using a gunflint.

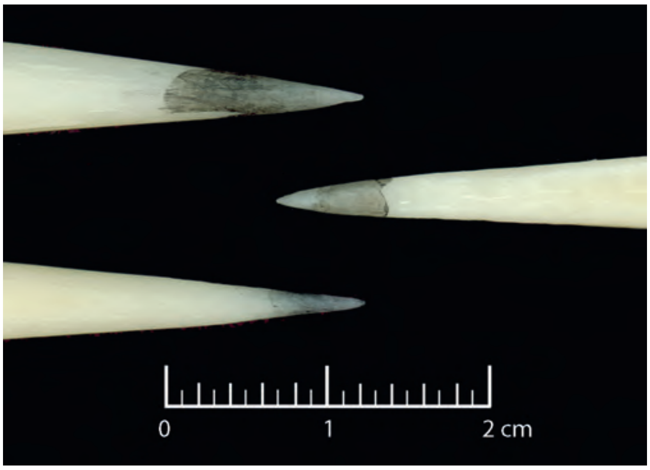

Figure 9. Deer bone needles used in experimental testing, showing pigment-stained tips.

A flint graver also proved extremely effective at tearing a deep linear gash through the flesh of the test subject (see Fig. 4j-k; Fig. 8). However, lines carved in the test subject using a graver spur allowed little control regarding the depth of the wound. In a living subject, the creation of such an injury would result in near-constant breaching of the dermal/epidermal boundary and massive blood flow that would inhibit the deposition of pigment. Once healed, the cut would more closely resemble the raised welts of scarification than the fine lines or shading of tattooing.

Finally, the distal tip of a tested graver spur proved well suited to in-line piercing. The tool easily punctured the epidermis of the test subject, and was relatively easy to manipulate and control in regard to depth and angle of the wound. Like the other lithic implements described above, graver spurs are irregularly shaped in cross section as a result of flake removal during the manufacturing process. The sharp margins of the spur therefore resulted in some instances of closely-grouped punctures merging together into a single wound.

Ultimately, experimental analysis identified finely-sharpened bone implements to be the most successful tools for hand picking a tattoo. These implements all provided excellent control over the depth and angle of skin penetration, and were able to create clean patterns of discrete punctures. These implements also allowed for the placement of adjacent punctures necessary to create a shaded line or area, while not generally widening or tearing into previous wounds.

4. Microscopy

Recent use-wear studies on bone tools have shown that wear patterns are a reliable indicator of tool type and can therefore aid in functional classification of an artefact (Byrd 2011). In addition, various electron microscopy techniques have been used with good success in the examination of use-wear on ancient tools (e.g., Villa & D'Errico 2001) and the composition of pigments in preserved tattoos (Pabst et al. 2009; 2010). As a final step in the current research, SEM and EDX analyses were used to examine select replicated and tested tools for distinctive use-wear and elemental signatures that might provide baseline data for identifying tattoo tools in archaeological collections. Three bone needles were selected as the subjects for this experiment based on the ethnohistorical and experimental examinations described above, and the availability of recent comparative use-wear studies (e.g., Buc 2011; Byrd 2011; Henshilwood et al. 2001) (Fig. 9).

The tools for the experiment were replicated from naturally-defleshed white-tailed deer (Odocoileus virginianus) metapodials using lithic tools, as previously described. After manufacture the bone tools were examined at the Middle Tennessee State University Interdisciplinary Microanalysis and Imaging Center (MIMIC) using a Hitachi S-3200-N SEM outfitted with an Oxford Inca EDX. These instruments were

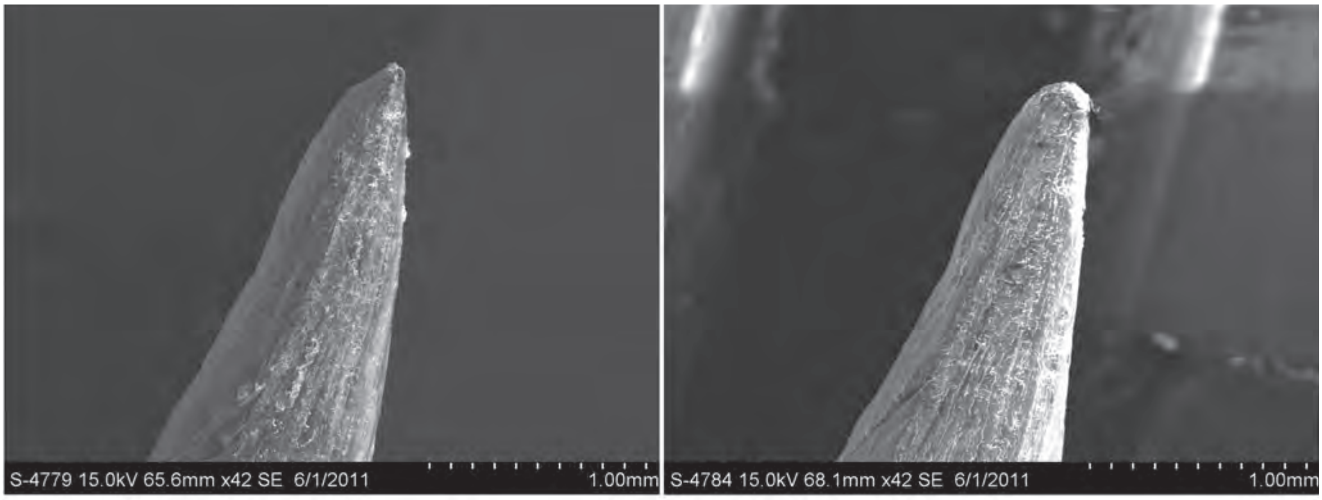

Figure 10. SEM images of a deer bone tool tip, before (left) and after (right) experimental tattooing.

used to document manufacturing wear patterns and examine the chemical/elemental character of the tool tips.

The three needles were then used for experimental tattooing of adult male pig remains under archaeological laboratory conditions. Pigment for this experiment consisted of simple India ink, comprised of fine soot suspended in water. Each bone tool was used to administer 200 punctures to the test subject, and was repeatedly dipped in ink during the tattooing process. Following testing, each bone needle was again examined using the SEM and EDX in order to identify use-wear patterns and test if their tips exhibited elevated levels of carbon resulting from contact with the tattoo pigment (Fig. 10).

Initial imaging of bone tools in the SEM revealed distinctive wear patterns resulting from the creation and sharpening process, including oblique "chattermarks" from lithic shaving. These marks were overlain and partially obliterated by parallel longitudinal striations from the abrading process. Following testing, the tools exhibited rounding and flattening of bone fibres along their apical ends, as well as an overall smoothing of longitudinal striations along the terminal portion of their tips.

The testing process resulted in general morphological changes to <0.5 mm of the tool tips, but did not produce any discernible wear patterns. This is interesting in light of the success other experiments have had in identifying distinctive wear on bone tools used to pierce hides and skins (e.g., Buc 2011). The lack of wear patterns created by tattooing during the current study may result from the limited number of punctures applied during the testing process, combined with the wear-reducing effects of working fresh (wet) skin (LeMoine 1991).

EDX analysis of the tool tips performed prior to the tattooing process identified the presence of various elements, including concentrations of oxygen (45 average weight percentage [wt%]), carbon (~27 wt%), calcium (~14 wt%), phosphorus (~8 wt%), iron (~1 wt%), and <0.5 wt% each of tungsten, sodium, magnesium, aluminium, and silicon. The majority of the elements present in small weight percentages were likely deposited on the needles during the shaping process. Although all three needles were cleaned with distilled water prior to the initial EDX examination, they were not thoroughly scrubbed or brushed in order to avoid altering manufacturing wear traces.

The bone tool tips were re-examined following tattooing in order to assess changes in their elemental signature, and specifically to test if elevated levels of carbon were present as a result of exposure to soot-based pigment. EDX analysis showed that oxygen (~42 wt%) and carbon (~25 wt%) remained the greatest portion of the elemental signature after tattooing. However, there was no spike in carbon levels, and the average weight percentage of both elements actually decreased slightly from pre-tattooing levels. Concentrations of calcium (~10 wt%), phosphorus (~6 wt%), and minor amounts of both sodium and magnesium (<0.4 wt%) all remained in the sample but also declined slightly. Post-tattoo analysis also revealed an unanticipated appearance of nitrogen (~15 wt%), which may relate to the use of nitrogen gas in modern meat processing.

Although the needle tips were visually stained with black pigment following testing (see Fig. 9), EDX analysis did not result in the identification of increased carbon indicative of exposure to soot concentrations in the tattoo ink. The limited exposure to carbon-based pigment during the relatively short duration of the test may have been insufficient to substantially alter the natural elemental signature of the tools. Over an extended use life, a tattoo tool may become infused with elemental traces of pigment that would be more easily detected. Future research should include extended test durations, as well as experimentation with other traditional tattoo pigments such as ochre (iron oxide or iron hydroxide), which are less concentrated in the atmosphere and therefore may produce a more distinct EDX signature.

5. Conclusions

This research was conducted in order to determine if ethnohistorical accounts, experimental archaeology, and microscopic analysis could provide new insights into the material remains of ancient tattooing in eastern North America. Ethnohistorical accounts from the sixteenth through nineteenth centuries are generally vague regarding the specific material(s) and construction of tattoo implements, but nevertheless indicate the use of various faunal, botanical, and lithic materials. Experimental testing reveals that although any of these tools may be used to pierce the epidermis and administer a tattoo, well-sharpened bone needles ultimately proved the most successful. However, the ethnohistorical record strongly suggests that implements identified as best-suited for tattooing in a modern setting were not the only ones used to administer tattoos in antiquity. Specific references to materials such as thorns and fish teeth indicate there was some variation among tools, probably according to material accessibility and ritual preferences. For these reasons, it is not possible to conclusively identify a specific class of tattoo needles in the archaeological record of the region based solely on ethnohistorical data or experimental tattooing.

All of the artefact types identified and tested during this research appear throughout the archaeological record, and may have served a variety of functional purposes including but not limited to tattooing. Additional tests were therefore conducted in order to determine if use-wear patterns or EDX analysis might provide baseline data for identifying tattoo tools in archaeological collections. Within the scope of the testing performed here, neither of these techniques appears to be a definitive tool in the search to identify ancient tattoo implements. It is possible that repetitive tool use and variations in pigment type could result in discernible wear and/or distinct elemental signatures, and these variables should be addressed in future research.

As with many elements of indigenous culture in eastern North America, European accounts of tattooing beginning in the sixteenth century describe the final manifestations of a widespread ancient tradition, the material remains of which have yet to be conclusively identified. Although ethnohistorical accounts, experimental archaeology, and microscopic analysis can provide some window into the material culture of prehistoric tattooing in the region, the specific archaeological footprint of the practice remains ephemeral at the present time. Future research including additional experimental testing, and EDX examinations, and residue analysis may help shed additional light on this significant and overlooked aspect of ancient Native American life.

Acknowledgements

This chapter is based on research presented at the 2009 (66th) Southeastern Archaeological Conference symposium "Tattooing and Body Modification in the Prehistoric and Early Historic Southeast," organized by Aaron Deter-Wolf, and the 2010 (16th) European Association of Archaeologists session "Tattoos and Body Modification in Antiquity," organized by Philippe Della Casa and Constanze Witt. Materials for experimental analysis were provided by Ed Warr and Bobby Wilson (Tennessee Wildlife Resources Agency), Allyse Ferrara and Quenton Fontenot (Nichols State University), Denise Weyer (Metro Nashville Parks), Bobby Hulan, and Ellis Durham. Additional research support was provided by Joyce Miller (MTSU Interdisciplinary Microanalysis and Imaging Center), Gage Myers, and Kim Vasut. Special thanks are due to Chris Saint Clark (http://Saintclark.com) from Kustom Thrills Tattoo in Nashville, Tennessee for his time, expertise, and steady hand. Finally, our appreciation goes out to Tennessee State Archaeologist Mike Moore and the MTSU Department of Sociology and Anthropology.

Bibliography

Adair J. & Holland Braund K. E. (ed.). (2005 [1775]). *The History of the American Indians*. (Tuscaloosa).

Atkinson M. (2003). *Tattooed: The Sociogenesis of a Body Art*. (Toronto).

Bartram W. (1791). *Travels Through North & South Carolina, Georgia, East & West Florida, the Cherokee Country, the Extensive Territories of the Muscogulges, or Creek Confederacy, and the Country of the Chactaws*. (Philadelphia).

Bossu J. B. (1771). *Travels Through That Part of America Formerly Called Louisiana*. (London).

Bressani F. G. (1899). *A Brief Account of Certain Missions of the Fathers of the Society of Jesus in New France*. In: Thwaites R. G. (ed. and trans.), Travels and Explorations of the Jesuit Missionaries in New France 1610-1791. The Jesuit Relations and Allied Documents 38, 203-291. (Cleveland).

Buc N. (2011). *Experimental Series and Use-Wear in Bone Tools*. Journal of Archaeological Science 38, 546-557.

Byrd J. C. (2011). *Archaic Bone Tools in the St. Johns River Basin, Florida: Microwear and Manufacture Traces*. Unpublished Master's thesis, Department of Anthropology, Florida State University. (Tallahassee).

Dale C. (2012). Lejre Archaological Research Centre. *Skin & Bone: Dotwork by Colin Dale*. http://skinandbonetattoo.blogspot.com/2012/07/lejre-archaological-research-center.html

Diaz-Granados C. (2004). *Marking Stone, Land, Body, and Spirit: Rock Art and Mississippian Iconography*. In: Townsend R. F. & Sharp R.V. (eds.) Hero, Hawk, and Open Hand: American Indian Art of the Ancient Midwest and South, 139-150. (Chicago).

Diaz-Granados C. & Duncan J. R. (2000). *The Petroglyphs and Pictographs of Missouri*. (Tuscaloosa).

De Dièreville S. & Webster J. C. (ed.). (1933 [1708]). *Relation of the Voyage to Port Royal in Acadia or New France*. (Toronto).

Dorsey G. A. (1903). *The Arapaho Sun Dance: The Ceremony of the Offerings Lodge*. Field Columbian Museum Publication 75, Anthropological Series, v. 4 (Chicago).

Dumont de Montigny J. B. (1753) *Mémoires Historiques sur la Louisiane, vol. 1*. (Paris).

Fox W. A. & Molto J. E. (1994). *The Shaman of Long Point*. Ontario Journal of Archaeology 57, 23-44.

Gatschet A. S. (1882). *The Shetimasha Indians of St. Mary's Parish, Southern Louisiana*. Transactions of the Anthropological Society of Washington 2, 148-159.

Giles B. T. (2010). *The Ritual Mnemonics of Hopewell Symbols: An Analysis of Effigies and Ceremonial Regalia from Tremper, Mound City, and Hopewell*. Ph.D. dissertation, Department of Anthropology, State University of New York at Bighamton. ProQuest/UMI Publication no. 3434600. (Ann Arbor).

Heckewelder J. G. E. (1876 [1818]). *History, Manners, and Customs of the Indian Nations Who Once Inhabited Pennsylvania and the Neighboring States. Memoirs of the Historical Society of Pennsylvania, vol. XI*I. (Philadelphia).

Henshilwood C. S., d'Errico F., Marean C. W., Milo R. G. & Yates R. (2001). *An Early Bone Tool Industry from the Middle Stone Age at Blombos Cave, South Africa: Implications for the Origins of Modern Human Behaviour, Symbolism and Language*. Journal of Human Evolution 41, 631–678.

Holmes W. H. (1880). *Art in Shell of the Ancient Americans*. Second Annual Report of the Bureau of Ethnology, 1880-'81, 179-305. (Washington, DC).

Isham J. & Rich E. E. (ed.). (1949 [1743]). *James Isham's Observations on Hudson's Bay, 1743, and Notes and Observations on a Book entitled A Voyage to Hudson's Bay in the Dobbs Galley, 1749*. (Toronto).

Jackson E. H. & Scott S. L. (2003). *Patterns of Elite Faunal Utilization at Moundville, Alabama*. American Antiquity 68 (3), 552–572.

James E. & Thwaites R. G. (ed.) (1905 [1823]). *Account of an Expedition from Pittsburgh to the Rocky Mountains, Performed in the Years 1819, 1820, vol. II.* (Cleveland).

Jouvency J. (1896). *Concerning the Country and Manners of the Canadians or Savages of New France.* In: Thwaites R. G. (ed. and trans.), Travels and Explorations of the Jesuit Missionaries in New France 1610-1791. The Jesuit Relations and Allied Documents 1, 239-298. (Cleveland).

Knight V. J. (2004). *Characterizing Elite Midden Deposits at Moundville.* American Antiquity 69 (2), 304-321.

Knight V. J. (2010). *Mound Excavations at Moundville: Architecture, Elites, and Social Order.* (Tuscaloosa).

Kononenko N. & Torrence R. (2009). *Tattooing in Melanesia: Local Invention or Lapita Introduction?* Antiquity 83 (320). Project Gallery. http://antiquity.ac.uk/projgall/kononenko/.

Lafitau J. F., Fenton, W. N. & Moore, E. L. (ed. and trans.) (1977 [1724]). *Customs of the American Indians Compared with Customs of Primitive Times, vol. II.* (Toronto).

Laudonnière R. G. de & Bennett C. E. (ed. and trans.). 2001 [1586]). *Three Voyages*. (Tuscaloosa).

Lawson J. (1937 [1709]). Lawson's History of North Carolina. (Richmond).

Le Challeux N. (1875 [1579]). *Histoire Memorable du Dernier Voyage en Floride par Le Challeux*. In Gaffarel P. (ed.), Histoire de la Floride Française. pp. 456-476. (Paris).

Le Page Du Pratz A. S. (1947 [1758]). *The History of Louisiana or of the Western parts of Virginia and Carolina*. (New Orleans).

LeMoine G. M. (1991). *Experimental Analysis of the Manufacture and Use of Bone and Antler Tools among the Mackenzie Inuit. Ph. D. Dissertation, Department of Archaeology,* University of Calgary. ProQuest/UMI Publication no. NN71195. (Ann Arbor).

Lewis T. M. N. & Kneberg M. (1946). *Hiwassee Island: An Archaeological Account of Four Tennessee Indian Peoples*. (Knoxville).

Long J. (1791). *Voyages and Travels of an Indian Interpreter and Trader.* (London).

Loskiel G. H. & La Trobe, C. I. (trans.) (1794). *History of the Mission of the United Brethren among the Indians in North America.* The Brethren Society for the Furtherance of the Gospel. (London).

MacCord H. A. (1953). *The Bintz Site.* American Antiquity 18 (3), 239-244.

McGrath J. A. & Uitto J. (2010). *Anatomy and Organization of Human Skin.* In: Burns T., Breathnach S., Cox N. & Griffiths C. (eds.). Rook's Textbook of Dermatology, Volume 1, Eighth Edition. (Oxford).

Major R. H. (ed. and trans.) (1870). *Select letters of Christopher Columbus With Other Original Documents Relating to His Four Voyages to the New World (2nd Ed.).* (London).

Mallery G. (1886). *Pictographs of the North American Indians: A Preliminary Paper.* Fourth Annual Report of the Bureau of American Ethnology, 1882-1883, 13-264. (Washington, D.C.)

Mallery G. (1893). *Picture-Writing of the American Indian*. Tenth Annual Report of the Bureau of American Ethnology, 1882-1883, 25-807. (Washington, D.C.)

Marest G. (1931). *Letter from Father Marest, Missionary of the Company of Jesus, to Father De Lamberville of the Company of Jesus, Overseer of the Missions of Canada.* In: Tyrrell J. B. (ed.), Documents Relating to the Early History of Hudson Bay, 103-142. (Toronto).

Margry P. (1887). *Découvertes et Établissements des Français dans l'Ouest et dans le Sud de l'Amérique Septentrionale, vol. 5.* (Paris).

Markham C. R. (ed. and trans.). (1893). *The Journal of Christopher Columbus (During his first voyage, 1492-93) and Documents Relating the Voyages of John Cabot and Gaspar Corte Real, 232-234.* (London).

Mills W. C. (1902). *Excavations of the Adena Mound.* Ohio State Archaeological and Historical Quarterly 10, 452–479.

Otto M. (1975). *A New Engraved Adena Tablet*. Ohio Archaeologist 25 (2), 31-36.

Pabst M. A., Letofsky-Papst I., Bock E., Moser M., Dorfer L., Egarter-Vigl E. & Hofer F. (2009). *The Tattoos of the Tyrolean Iceman: A Light Microscopical, Ultrastructural and Element Analytical Study.* Journal of Archaeological Science 37, 2335-2341.

Pabst M. A., Letofsky-Papst I. Moser M., Spindler K., Bock E., Wilhelm P., Dorfer L., Geigl J. B., Auer M., Speicher M. R. & Hofer F. (2010). *Different Staining Substances Were Used in Decorative and Therapeutic Tattoos in a 1000-Year Old Peruvian Mummy.* Journal of Archaeological Science 37, 3256-3262.

Painter F. (1977). *Possible Evidence of Tattooing by Paleo-Indians of Eastern North America*. The Chesopiean 15, 28-34.

Payne E. J. (ed.). (1907). *Voyages of Hawkins, Frobisher and Drake: Select Narratives from the 'Principal Navigations' of Hakluyt*. (Oxford).

Peres T. M. (2010). *Zooarchaeological Remains from the 1998 Fewkes Site Excavations, Williamson County, Tennessee*. Tennessee Archaeology 5 (1), 100-125.

Raudot A. D. (1904). *Lettre XXIVe: Des Sauvages et des Sauvagesses et de Leur Habillement et de la Maniere de se Piquer.* In de Rochemonteix C. (ed.), Relation par Lettres de l'Amérique Septentrionalle (Années 1709 et 1710), pp.63-65. (Paris).

Reime E. (2003) *Tattooed with Flintstone. Kunsten på Kroppen: The Art of Tattooing.* http://www.tattoo.dk/eriks/handtattoo/flintesten_e.html

Sagard-Théodat G. (1866). *Histoire du Canada, vol. 2. M.* (Paris).

Sinclair A. T. (1909) *Tattooing of the North American Indians*. American Anthropologist 11 (3), 362–400.

Smith J. (1907 [1624]). *The Generall Historie of Virginia, New England & the Summer Isles, vol. I.* (Glasgow).

Swanton J. R. (1987). *Indians of the Southeastern United States*. (Washington, D.C.)

Swartz B. K. (2001). *A Survey of Adena-Hopewell (Scioto) Anthropomorphic Portraiture*. In: Stocker T. & Charlton C. L. O. The New World Figurine Project, vol. 2, 225-252. (Provo).

Swindle M. M. (2008). *Porcine Integumentary System Models: Part 1 - Dermal Toxicology.* Technical Bulletin, Sinclair Research Center, Inc. (Columbia). http://www.sinclairresearch.com/Downloads/TechnicalBulletins/Porcine%20Integumentary%20System%20Model-Part%201.pdf

Vale V. & Juno A. (eds.). (1989). *Modern Primitives: An Investigation of Contemporary Adornment & Ritual.* (San Francisco).

Villa P., & D'Errico F. (2001). *Bone and Ivory Points in the Lower and Middle Paleolithic of Europe*. Journal of Human Evolution 41, 69-112.

Walker C. P. (2004). *Prehistoric Art of the Central Mississippi Valley.* In: Townsend R. F. & Sharp R. V. (eds.), Hero, Hawk, and Open Hand: American Indian Art of the Ancient Midwest and South, 219–230. (Chicago).

Wallace A. B. (1993). *Southeastern American Indian Body Decoration: Forms and Function.* Unpublished Master's thesis, Department of Anthropology and Archaeology, Harvard University. (Cambridge).